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An Economic Analysis of Final Effluent Limitations Guidelines, New Source Performance Standards, and Pretreatment Standards for the Iron and Steel Manufacturing Point Source Category

Temple, Barker and Sloane, Inc.
Lexington, MA

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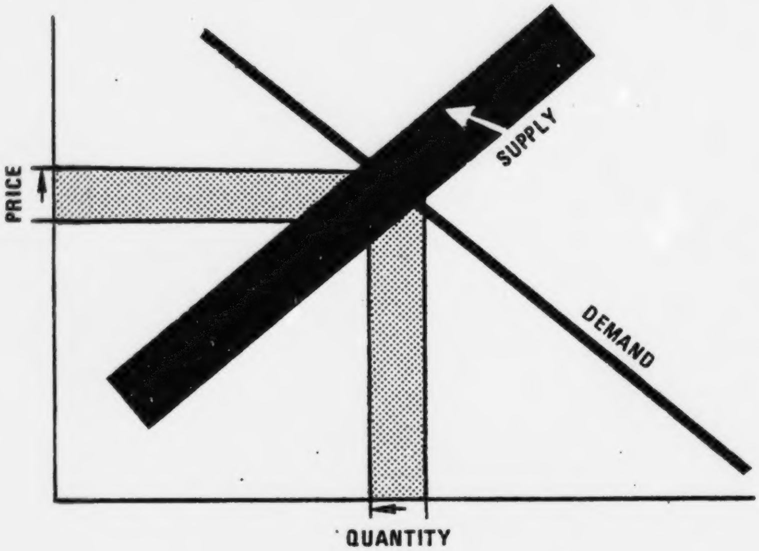

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EXECUTIVE SUMMARY

This report examines the economic effects of the final water pollution control regulation on the iron and steel industry. It focuses on the regulation's potential impacts on the steel industry's prices, financial condition, and production capacity. The study effort was sponsored by the Office of Policy Analysis of the U.S. Environmental Protection Agency (EPA) as part of the EPA's overall review of the water pollution control regulation for the iron and steel industry.

The report presents the results of a 36-month study conducted by Temple, Barker & Sloane, Inc. (TBS). To analyze the production, pollution control, and financial characteristics of the iron and steel industry, TBS employed its policy-testing model of the steel industry, PTm(Steel). PTm(Steel) combines a methodology for calculating economic effects with the production cost impact methodology employed by the American Iron and Steel Institute (AISI) in its investigation of pollution control costs. This combination permits an integrated analysis of the costs and economic effects of environmental regulations.

TBS's analysis focused on the impact of pollution control costs on the steel industry in light of the capital constraints the industry is likely to face during the next decade. TBS assumed that the current government policies toward the industry would continue throughout the 1980s. These include the current provisions of the Economic Recovery Tax Act of 1981 concerning corporate income tax rates, depreciation schedules, and investment tax credits; the relaxation of formal and informal steel price controls; and the effective enforcement of steel trade laws, such as the trigger price mechanism.

In terms of approach, the analysis focused on two time periods--1980 to 1985 and 1980 to 1990--and was developed using two scenarios for the future demand for domestically produced steel products. A fairly profitable scenario with rapid growth in shipments (Scenario 1) was based on an AISI projection of steel shipments of 108 million tons in 1985 and 116 million tons in 1990, which would result in capacity constraints throughout most of the 1980s. A less profitable, less expansionary scenario (Scenario 2) was based on an econometric model of future industrial production, which projected shipments of 103.2 million tons in 1985 and 108.3 million tons in 1990. The second scenario would result in underutilized capacity for most of the 1980s.

Our findings were considerably different for Scenario 1 and Scenario 2. In Scenario 1, high capacity utilization in the industry would lead to higher profitability than that experienced by the industry during the 1970s. These profits would ultimately allow the steel industry to attract adequate capital to finance expenditures for both added production capacity and pollution control equipment. Consequently, in Scenario 1 the required pollution control expenditures would have an effect on production in the short term, when capital spent on pollution control would otherwise be needed for expansion. This effect would be virtually eliminated in the long term. However, the impact on price, although not significant, would be more pronounced in the long term.

In Scenario 2--where continued low profits and constraints on capital would persist throughout the 1980s--the costs of pollution control would result in more persistent production impacts. Initially, these impacts would be similar in magnitude to the short-term impacts in Scenario 1. However, by the early 1990s, an improved cash flow position would allow the industry to recover from the impacts of pollution control costs. Thus, under each scenario, the impacts of pollution control would have an insignificant long-run effect. Additional pollution controls would not have an impact on production and would cause only a 0.6 percent increase in prices. Exhibit E-1 provides a summary of these results.

The remainder of this summary elaborates on these findings. The scope, methodology, and major assumptions of the TBS analysis are described in the next two sections. Subsequent sections review TBS's analysis of the steel industry's future financial and economic condition in the absence of the final water pollution control regulation and then examine how the water regulation would affect the industry. The sensitivity analyses that were performed to examine several major assumptions used in the study are then discussed. The final sections summarize the impacts of the water pollution control regulation on the merchant coke and the merchant pig iron industries.

SCOPE OF THE STUDY

For the purpose of this study, the steel industry was defined as those production process units normally associated with steel production and finishing. Thus, on-site facilities ranging from raw material storage yards for coke ovens and blast furnaces to finishing mills were considered part of the steel industry. Also included in the industry definition were facilities used by the steel industry to produce pig iron for foundries and other uses. Facilities for the mining, beneficiation, and transportation of raw materials, fabrication facilities, and all nonsteel operations performed by steel firms were excluded from the analysis. In order to utilize the detailed operating data compiled by AISI members, TBS limited its analysis to steel industry operations that accounted for approximately 87 percent of U.S. raw steel production capability in 1980. Separate analyses of the merchant coke and merchant pig iron industries were also performed, as described later in this Summary.

The environmental regulations considered in this report were those promulgated, proposed, or anticipated by the EPA as of August 1980 for air pollution controls and as of December 1981 for water pollution controls. In addition, those costs related to the Resource Conservation and Recovery Act (RCRA) that are associated with the water pollution control regulation were included.

The engineering cost estimates and compliance schedules associated with environmental control efforts were based on compliance by the steel firms at the plant sites. Summaries of these costs are provided in Exhibits E-2A and E-2B. The costs do not include control efforts by municipal wastewater treatment facilities associated with the effluent from indirectly discharging steel producers.

The analysis of the financial and economic conditions of each scenario focused on two time periods: a short-term period--from 1980 to 1985--and a long-term period--from 1980 to 1990. The year 1980 was chosen to begin each of the periods because the financial impacts of added pollution control equipment (to be installed in 1982 and thereafter) would begin two years prior to installation of the pollution control equipment. The year 1985 was chosen to end the short-term period because maximum declines in capacity and market share were observed in that year. The year 1990 was chosen to end the long-term period because the long-term financial and economic impacts would be apparent by that time.

METHODOLOGY AND MAJOR ASSUMPTIONS

In order to determine the economic effects of effluent guidelines on the iron and steel industry, it was necessary to establish two scenarios that would reflect the major uncertainty currently facing the industry--the demand for steel products during the next decade. Annual shipment levels for the two scenarios are presented in Table E-1. Although the difference in 1990 in the steel shipment levels of the two scenarios appears slight--116 million tons in Scenario 1 and 108.3 million tons in Scenario 2--it is sufficient to distinguish between a fully utilized, reasonably profitable, expansionary steel industry, and a capital-constrained, marginally profitable steel industry. TBS believes that both scenarios should be considered with equal weight given the narrowness of the range between them, the resulting difference in the industry's financial condition, and the major uncertainties in the nation's future economic condition.

Table E-1

SCENARIOS FOR DOMESTIC SHIPMENTS OF FINISHED STEEL PRODUCTS

(millions of tons per year)

	Scenario 1	Scenario 2
1981	92.0	92.0
1982	98.0	96.5
1983	105.0	99.3
1984	106.0	103.9
1985	108.0	103.2
1986	109.0	99.8
1987	111.0	96.2
1988	112.0	101.5
1989	114.0	108.9
1990	116.0	108.3

Source: ADL and TBS projections.

Although Scenarios 1 and 2 were designed to capture what TBS considered the most important future uncertainty facing the steel industry in the 1980s, certain other assumptions required further analysis. These included water pollution control cost estimates, the relationship between future cost savings and industry profits, and the impact of higher inflation rates on the industry's financial condition. In addition, the financial impacts of the air compliance stretchout (the extension of air pollution control costs recently permitted by Congress) were examined. Each issue was addressed in a sensitivity analysis.

The shipment levels in Scenario 1 were based on forecasts presented in the Arthur D. Little, Inc. (ADL) report to the AISI, Environmental Policy for the 1980s: Impact on the American Steel Industry (1980). To develop Scenario 2 shipment estimates, TBS used production indices obtained from Data Resources, Inc. (DRI) and adjusted them to reflect the effects of automobile downsizing (a reduction in steel demand of about 6 million tons by 1985). The shipment estimate was also smoothed to reduce the importance of the timing of business cycles in the DRI forecast.

With the exception of projected shipments, the major assumptions in Scenarios 1 and 2 were the same. These included assumptions concerning the nature of the industry's future profitability, the industry's ability to raise debt and equity capital, the impact of reduced investment in plant and equipment on production capability, and improvements in industry cost structure that would result from future plant closures.

TBS assumed that industry profitability would be based on the utilization of raw steelmaking capacity. In the period 1970 to 1980 (except for the boom years 1973 and 1974), raw steel utilization averaged 82 percent, and the industry rate of return on equity averaged the rate of inflation. In 1973 and 1974, utilization averaged 97 percent, and return on equity approximated the return for nonfinancial corporations. On the basis of this evidence, TBS assumed an industry return on equity equal to the rate of inflation when the utilization of raw steelmaking capacity was less than or equal to 85 percent. When utilization was 100 percent, TBS assumed an industry return on equity equal to the average rate of return for nonfinancial corporations. When it was greater than 85 percent, the rate of return was calculated by interpolating between the two points.

Profitability affects the steel industry's future in at least three important ways. First, profits provide returns to its stockholders as well as much of the cash the industry uses to finance investments needed for the maintenance and expansion of its capital stock. Second, current high profits provide assurance to potential purchasers of steel industry common stock that they will receive a return on their investment. Thus, high profits ensure that market prices for common stock will be high, allowing companies to issue additional common stock without dilution of present shareholders' interests. Third, poor profits diminish the industry's credit rating and therefore limit its ability to raise capital through the issuance of debt.

In the 1970s, low profitability, coupled with large capital expenditures for production facilities and pollution control equipment, essentially eliminated the steel industry's access to equity capital and stretched its ability to issue additional debt. As a result, the credit quality of steel industry debt declined.

Additional issues of debt would tend to degrade key measures of credit quality such as the cash-flow-to-long-term-debt ratio, the interest coverage ratio, and, most important, the debt-to-capitalization ratio. The bulk of the industry is given a credit rating of A by Standard & Poor's and Moody's. Issues of debt that would further degrade the industry's credit quality would reduce the industry's rating to the lowest investment grade (Standard & Poor's BBB and Moody's Baa) or, worse yet, below investment grade. Under normal credit market conditions, a BBB/Baa-rated company is relatively assured of having access to debt capital on reasonable terms. However, during tight credit market conditions, these companies may not be able to raise their capital requirements on reasonable terms. Consequently, the additional costs and potential financing difficulties associated with a BBB/Baa rating (or lower) are likely to lead steel industry managements to constrain their capital expenditures and debt financing to levels consistent with the preservation of an A bond quality rating.

The TBS analysis reflects the foregoing financial considerations in two important ways. First, it was assumed that common stock financing would not be undertaken by the steel industry unless it could demonstrate a long-term profit potential for several years. This assumption is reasonable in light of the current low market-to-book value--near 50 percent--of steel industry common stock. Before common stock could be issued, the industry would have to achieve returns on equity approaching that of the average for U.S. manufacturing firms. Second, the industry's debt-to-capitalization ratio was limited to approximately 35 percent in order to preserve the industry's current credit rating. Any further decline could restrict its access to debt capital in the future. This limit on debt financing in turn implied limits on the capital expenditures that the industry would likely undertake. It was assumed that the industry would probably reduce capital expenditures invested in its existing facilities to levels below those considered desirable by knowledgeable industry sources. This is a conservative assumption because other sources of funds, such as the sale of nonsteel businesses or coal reserves, may be available. However, the assumption is reasonable because the expenditure of outside funds on the steel industry is unlikely since the resulting return on investment would be poor. Reductions in expenditures for existing equipment would make it more difficult for the industry to maintain its current levels of improvement in productivity, quality, energy conservation, and cost reduction. Moreover, the industry would be less able to meet U.S. steel requirements during future periods of high demand and would thus lose a part of its share of the U.S. steel market.

The degree to which capacity would shrink would depend on the reduction in capital investment relative to the replacement value of the industry's capital stock. Based on industry information recently updated by TBS, the replacement value of the capital stock of the U.S. steel industry is approximately $81.1 billion in 1980 dollars. Of this, approximately 2.2 percent, or $1.8 billion, must be spent each year on existing equipment to maintain efficiency and competitiveness and to adjust for changes in technology and product mix. Reductions in investment in capital stock from this level would cause the value of the capital stock to decrease by an equal amount. For example, a $1.0 billion reduction would result in a 1.2 percent decline in shipment capability, or about 1.2 million tons annually. If reduced capability were to coincide with a period of high demand for steel products, then production, employment, and market share declines would be more pronounced.

A final major assumption in the TBS analysis relates to the operating cost savings resulting from the closing of inefficient plants. On the basis of data provided in ADL's report to the AISI, TBS assumed a cost savings of $80 of annual savings per ton for the first 3 million tons of capacity closed. For closures beyond 3 million tons, a cost savings of $30 per ton was used.

CONDITION OF THE STEEL INDUSTRY WITHOUT ADDITIONAL WATER POLLUTION CONTROL COSTS

The financial and economic impacts of additional water pollution control costs on the steel industry were evaluated by first establishing a baseline condition (reference point) for each of the two scenarios. These baselines included the cost to the industry of production, in-place and projected air pollution control equipment, and in-place water pollution control equipment.

The following sections describe the baseline financial and economic conditions for the two scenarios. Financial condition is depicted in terms of five key factors: capital expenditures for new equipment, capital expenditures for existing equipment, external financing needs, operations and maintenance (O&M) costs, and revenue requirements. Economic condition is defined in terms of the average price of steel, declines in capacity resulting from constraints on capital, production levels, market share, and employment.

The modeling performed in PTm(Steel) projects steel industry production costs and revenues based on the industry's shipping 84.5 percent of the steel demanded by the domestic market (Table E-2). In the following sections (and throughout the report), production costs, prices, and revenues are reported on this basis. However, capacity constraints in the 1980s will prevent the industry from attaining a full 84.5 percent market share. Production and employment projections are reported based on this reduced market share.

Scenario 1

The Scenario 1 baseline condition of the steel industry for the years 1985 and 1990 is illustrated in Table E-2 and detailed in Exhibits E-3 through E-6. To maintain its current bond rating, the industry would need to reduce its capital expenditures on existing equipment by about $813.3 million per year through 1985. This sustained reduction would lead to a decline in production capability of about 6.9 million tons of finished steel products. Consequently, at a utilization rate of 90 percent for raw steelmaking processes, only 98.8 million tons could actually be shipped, compared with a projected demand of 108 million tons. If the excess demand were supplied by imports, then market share in 1985 would decline 7.2 percentage points to 77.3 percent.

By 1987, continuing capacity constraints and the accompanying high profitability would allow the steel industry to issue large amounts of common stock. This, along with increased profitability and the tax reductions associated with the Economic Recovery Tax Act, would provide the funds needed to reduce the backlog of delayed expenditures on existing equipment and to expand capacity to regain the industry's current market share of about 84.5 percent by 1990.

Table E-2

SUMMARY OF THE BASELINE CONDITIONS

	Scenario 1		Scenario 2	
	Short Term (1980-1985)	Long Term[1] (1980-1990)	Short Term (1980-1985)	Long Term (1980-1990)
Capital Expenditures (millions of 1980 dollars)				
New Production Equipment	$ 8,640.5	$12,873.4	$ 8,602.8	$10,357.1
Pollution Controls	2,316.5	2,494.6	2,291.1	2,348.2
Existing Production Equipment	6,531.6	18,566.5	7,251.2	17,643.8
Total	$17,488.6	$33,934.5	$18,145.1	$30,349.1
Annual O&M Expenses (millions of 1980 dollars)[2,3,5]				
Production	$41,408.7	$47,589.0	$39,863.4	$44,332.3
Pollution Controls	1,016.1	1,114.1	965.2	1,040.6
Total	$42,424.8	$48,703.1	$40,828.6	$45,372.9
Revenue Requirements (millions of 1980 dollars)[2,5]	$50,564.9	$56,962.1	$48,259.3	$52,845.1
Average Price ($/ton)[2]	$533.86	$558.80	$533.21	$555.28
Domestic Production (millions of tons)[2,4]				
Demanded	108.0	116.0	103.2	108.3
Supplied	98.8	116.0	101.2	103.4
Shortfall	9.2	0.0	2.0	4.9
Market Share (percent)[2,4]	77.28%	84.50%	82.87%	80.67%
Employment (thousands of employees)[2]	425.78	459.11	448.67	401.86

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[1] Improved financial condition would allow the industry to achieve an 84.5 percent market share in the early 1990s.

[2] End of period estimate.

[3] Includes cost savings resulting from closure of inefficient plants.

[4] Total U.S. projected shipments of steel; includes producers not in financial statistics.

[5] O&M and revenue based on an 84.5 percent market share.

Source: TBS analysis.

Scenario 2

In Scenario 2, the industry's baseline condition is substantially different. Table E-2 summarizes the baseline condition, and Exhibits E-7 through E-10 provide additional information. Capital expenditures on existing equipment would need to be reduced by an average of $693.4 million per year below desired levels through 1985 for the steel industry to maintain its bond ratings. This reduction would result in a decline in production capacity of about 6.0 million tons per year, which would contribute to a decline in the industry's market share from 84.5 percent to 82.9 percent.

After 1985, a combination of factors would allow the steel industry to begin to recover slowly from declines in production capacity. These factors include the tax reductions associated with the Economic Recovery Tax Act and the higher profitability stemming from higher utilization rates. In 1990, a year of cyclically high demand, market share would fall to 80.67 percent. However, by 1990, the industry would be able to rework and modernize much of its inefficient equipment. Although the steel industry would not be able to issue significant amounts of common stock by the early 1990s, its financial condition would improve markedly, and it would be left with adequate funds to regain and maintain its competitive position.

EFFECTS OF ADDITIONAL WATER POLLUTION CONTROL COSTS

Based on EPA technical data, TBS estimated that the capital expenditures for water pollution control equipment needed to comply with EPA's final effluent guidelines for currently installed steel facilities would total $309.6 million for the 1982-1984 period.[1] Water pollution controls for new steel facilities built by 1990 would require additional capital expenditures of $420.5 million in Scenario 1 and $273.2 million in Scenario 2. In 1985 (when the steel industry would be capital constrained in both Scenario 1 and Scenario 2), these added expenditures would result in further reductions in capital expenditures for existing production equipment beyond those described in each baseline condition. These further reduced capital expenditures would in turn cause further declines in production capacity and, when the industry was capacity constrained, would lead to declines in production, market share, and employment. By 1990, adequate capital would be available to the industry so that pollution controls would not result in measurable economic impacts. Prices would increase less than 0.6 percent as a result of added water costs. Table E-3 details the incremental impact of added water pollution control costs.

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[1] Small differences in capital cost estimates developed by TBS and EPA's technical contractor are described in Chapter III.

Scenario 1

In Scenario 1, additional water pollution control capital costs of $463.1 million by 1985 would necessitate reducing capital expenditures on existing equipment by $505.4 million. This would create a decline in production capacity of 0.6 million tons per year and would lead to a reduction in market share of 0.48 percentage points to 76.8 percent. Although employment in water pollution control operations would increase by 520 jobs, the decline in steel production would cause a net reduction of 2,180 employees (0.5 percent of baseline employment). Between 1985 and 1990, an additional $267.0 million in capital expenditures would be spent for water pollution controls at new facilities. However, by 1990 the strong financial condition of the industry would substantially reduce the negative economic impacts of pollution controls, and employment would increase by 850 jobs over baseline levels (0.2 percent of baseline employment), primarily for the operation of added pollution control equipment.

Scenario 2

The economic effects of additional water pollution controls in 1985 are very similar in Scenarios 1 and 2. In Scenario 2, capital expenditures for added water pollution controls would amount to $462.8 million by 1985 and would cause capital expenditures for existing equipment to decline by $494.4 million. As a result, annual production capacity would decline by 0.7 million tons, market share would drop 0.6 percentage points to 82.3 percent, and employment would decrease by 2,470 workers (0.5 percent of baseline employment). These effects would be substantially reduced by 1990, because of the improving financial condition of the industry, and would be virtually eliminated by the early 1990s, except for a 0.6 percent increase in price.

Table E-3

SUMMARY OF THE EFFECTS OF ADDITIONAL
WATER POLLUTION CONTROL COSTS[1]

	Scenario 1		Scenario 2	
	Short Term (1980-1985)	Long Term[2] (1980-1990)	Short Term (1980-1985)	Long Term (1980-1990)
Capital Expenditures (millions of 1980 dollars)				
New Production Equipment	$ 0.0	$ 0.0	$ 0.0	$ 0.0
Pollution Controls	463.1	730.1	462.8	582.7
Existing Production Equipment	-505.4	0.0	-494.4	-396.5
Total	$-42.3	$730.1	$-31.6	$186.2
Annual O&M Expenses (millions of 1980 dollars)				
Pollution Controls	$32.5	$61.4	$35.3	$46.4
Less Added Cost Savings[3]	15.0	14.1	12.1	9.9
Total	$17.5	$47.3	$23.2	$36.5
Revenue Requirements (millions of 1980 dollars)	$125.1	$331.8	$118.0	$137.4
Average Price ($/ton)	$1.32	$3.26	$1.31	$1.44[a]
Domestic Production (millions of tons)	-0.62	0.00	-0.67	-0.44
Market Share (percent)	-0.48%	0.00%	-0.55%	-0.34%
Employment (thousands of employees)	-2.18	0.85	-2.47	-1.08

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[1] Information in this table represents changes from the baseline resulting from added water pollution control costs.

[2] Improved financial condition would permit the industry to achieve an 84.5 percent market share by 1990.

[3] Cost savings resulting from transfer of production from inefficient plants.

[a] This price effect would increase to about $3.30 in 1991-1993 as capital constraints are relaxed.

Source: TBS analysis.

SENSITIVITY ANALYSES

TBS conducted four sensitivity analyses to examine several of the assumptions in this study. The analyses involved modifications to assumptions regarding inflation rates, water costs, stretchout of air costs, and pass-through of cost savings. The sensitivity analyses were performed only on Scenario 1. The following sections describe these analyses, and Exhibits E-11 through E-14 provide details of the results.

Sensitivity 1: Higher Inflation Rates

The inflation rates used in Scenarios 1 and 2 were based on a DRI econometric model that was adjusted to match the current Administration's projections for inflation and gross national product (GNP). The GNP price deflator implicit in this adjusted model averaged 5.7 percent per year through 1990, compared with DRI's unadjusted projection of 8.8 percent. Sensitivity 1 was based on the interest rates of DRI's unadjusted projections. This sensitivity analysis indicates that while inflation assumptions have a slight effect on the baseline condition, they have virtually no effect on the impact of added water pollution control costs.

Sensitivity 2: Doubled Water Costs

While the water pollution control cost estimates used by TBS were based on the most accurate estimates currently available, different estimates based on alternative assumptions would result in different economic impacts. Sensitivity 2 examines the economic impact that would result if the capital costs for water pollution controls were double the current estimates. The impacts were found to be roughly in proportion to the increased costs, and they still remained relatively small.

Sensitivity 3: Air Stretchout

Congress has allowed the EPA to permit steel companies to stretch out the construction of certain air pollution control equipment. Recent information indicates that about $200 million of outstanding air pollution expenditures may be postponed. Sensitivity 3 shows that the financial and economic benefits of this relaxation in regulation are likely to be quite small.

Sensitivity 4: Cost Savings Pass-Through to Profits

As the steel industry is forced by constraints on capital to close its inefficient plants, the operating costs of the industry will be reduced. In its methodology, TBS assumed that these cost savings would be passed on to the purchasers of finished steel products. TBS believes that in a cost-driven market such as the market for steel products (where prices increase at about the rate of inflation), small industrywide decreases in operating cost are quickly translated into small decreases in the rate of price increases. To test the sensitivity of this assumption, TBS increased industry operating profits by the amount of the cost savings. As a result, the baseline condition of the industry improved somewhat. However, the incremental economic impacts of water pollution controls remained roughly the same regardless of the pass-through assumption.

EFFECTS OF WATER POLLUTION CONTROLS ON THE MERCHANT COKE INDUSTRY

Impacts on the merchant coke industry were obtained by examining the effects of the regulation on three key parameters: the annual costs as a percentage of total cash flow, the debt-to-capitalization ratio, and capital costs as a percentage of replacement value. Model plant costs for BPT, BAT, and PSES treatments, supplied by EPA's technical contractor, NUS/Rice, were scaled to appropriate plant capacities and then summed. As shown in Table E-4, the industry's annual costs for all treatments at full capacity utilization are about $5.0 million in 1980 dollars. This is approximately 20 percent of current total cash flow. Based on a 1980 price of $135 per ton and 9.5 million tons of production, the added annual costs passed on to consumers will cause prices to increase by 0.4 percent. Assuming that the $18.8 million capital investment required to install treatment is funded entirely by debt, the merchant coke industry debt-to-capitalization ratio is projected to move from 39.1 percent to about 39.7 percent.

Table E-4

MERCHANT COKE INDUSTRY
INCREMENTAL EFFLUENT REGULATION COSTS

(millions of 1980 dollars)

	Capital Cost	Annual Cost[1]
BPT	$ 3.0	$0.8
BAT	5.5	1.6
PSES	10.3	2.6
Total	$18.8	$5.0

---

[1] Based on a capital recovery factor of 8.99 percent.

Source: TBS analysis.

Based on a current annual capacity of 9.5 million tons per year, the replacement value of the merchant coke industry at $220 per ton would be $2.1 billion. Total capital costs for compliance are projected to be $18.8 million, or 0.9 percent of the replacement value. If these expenditures for pollution controls were diverted from capital expenditures that otherwise would be made to maintain production equipment, then a loss of productive capability of about 0.9 percent could be expected. As a result, in future periods of capacity constraints, about 0.9 percent of production, or about 85,500 tons, would be lost to foreign producers. The percentage impact on employment is expected to be similar in magnitude.

Impacts on individual firms in the merchant coke industry are not disproportionately out of line with these small industrywide impacts. Because of this, the water regulation is unlikely to force the closure of any merchant coke facilities.

EFFECTS OF WATER POLLUTION CONTROLS ON THE MERCHANT PIG IRON INDUSTRY

The merchant pig iron industry consists of two firms that produce pig iron for casting. This industry is currently facing extensive competition from imports. A total of

$1.91 million in added capital expenditures will be needed to meet the requirements of BPT effluent guidelines, and about $0.73 million will be needed to meet BAT guidelines. Annual costs for these requirements of about $0.5 million per year are likely to increase prices by 0.2 percent. These requirements represent 2.4 percent of the industry's replacement value (based on an industry capacity of 1.2 million tons per year and a replacement cost of $92 per ton). In periods of future capacity constraints, which at present appear unlikely, reductions in production of as much as 2.4 percent could be attributed to added water pollution controls. During such periods, employment would be impacted by a similar percentage. An analysis of the financial impacts of the water regulation is not presented because financial data were provided to EPA by the industry on a confidential basis. The results of the analysis indicated that any future scrapping of pig iron furnaces would most likely result from declining industry profitability and market share rather than from the costs of added water pollution controls.

Exhibit E-1

SUMMARY OF ECONOMIC IMPACTS OF FINAL WATER POLLUTION CONTROL REGULATIONS

	Price (1980 dollars per ton)			Production (millions of tons per year)			Market Share (percent)			Employment (thousands of employees)		
	1984	1985	1990	1984	1985	1990	1984	1985	1990	1984	1985	1990
Scenario 1												
Baseline	$519.33	$533.86	$558.80	100.71	98.77	116.00	80.28%	77.28%	84.50%	441.66	425.78	459.11
Added Water Costs	0.78	1.32	3.26	-0.61	-0.62	0.00	-0.48	-0.48	0.00	-2.18	-2.18	0.85
Baseline and Added Water Costs	$520.11	$535.18	$562.06	100.10	98.15	116.00	79.80%	76.80%	84.50%	439.48	423.60	459.96
Scenario 2												
Baseline	$519.45	$533.21	$555.28	102.71	101.21	103.39	83.53%	82.87%	80.67%	462.54	448.67	401.86
Added Water Costs	0.73	1.31	1.44	-0.65	-0.67	-0.44	-0.52	-0.55	-0.34	-2.39	-2.47	-1.08
Baseline and Added Water Costs	$520.18	$534.52	$556.72	102.06	100.54	102.95	83.01%	82.32%	80.33%	460.15	446.20	400.78
Sensitivity 1--DRI Inflation												
Baseline	$513.11	$522.93	$531.04	101.15	99.74	116.00	80.63%	78.04%	84.50%	443.60	429.97	459.11
Added Water Costs	0.72	1.21	2.92	-0.60	-0.60	0.00	-0.48	-0.47	0.00	-2.16	-2.10	0.85
Baseline and Added Water Costs	$513.83	$524.14	$533.96	100.55	99.14	116.00	80.15%	77.57%	84.50%	441.44	427.87	459.96
Sensitivity 2--Double Water Costs												
Baseline	$520.65	$535.04	$559.29	100.69	98.86	116.00	80.27%	77.35%	84.50%	441.59	426.19	459.11
Added Water Costs	1.12	2.13	5.30	-1.21	-1.23	0.00	-0.97	-0.96	0.00	-4.83	-4.84	0.85
Baseline and Added Water Costs	$521.77	$537.17	$564.59	99.48	97.63	116.00	79.30%	76.39%	84.50%	436.76	421.35	459.96
Sensitivity 3--Air Stretchout												
Baseline	$517.76	$532.85	$559.06	101.11	98.89	116.00	80.60%	77.37%	84.50%	442.82	426.31	459.11
Added Water Costs	0.73	1.24	2.96	-0.62	-0.62	0.00	-0.49	-0.48	0.00	-2.21	-2.21	0.85
Baseline and Added Water Costs	$518.49	$534.09	$562.02	100.49	98.27	116.00	80.11%	76.89%	84.50%	440.61	424.10	459.96
Sensitivity 4--Cost Savings Pass-Through												
Baseline	$528.42	$545.30	$565.23	101.52	98.93	116.00	80.93%	78.19%	84.50%	445.23	430.80	459.11
Added Water Costs	1.18	1.77	3.19	-0.59	-0.59	0.00	-0.47	-0.46	0.00	-2.13	-2.07	0.85
Baseline and Added Water Costs	$529.60	$547.07	$568.42	100.93	99.34	116.00	80.49%	77.73%	84.50%	443.10	428.73	459.96

Source: TBS analysis.

Exhibit E-2A

STEEL INDUSTRY
EFFLUENT REGULATION COSTS

SCENARIO 1

(millions of 1980 dollars)

	Capital Costs[1]		
	Facilities In Place[2]	Facilities Required 1981-1990	Total
BPT	$1,771.6	$213.2	$1,984.8
BAT	26.4	70.1	96.5
PSES	116.8	26.3	143.1
NSPS	0	420.5	420.5
PSNS	N/A	N/A	N/A
Total	$1,914.8	$730.1	$2,644.9

	Annual Costs[3]			
	Incremental		Total[4]	
	1984	1990	1984	1990
BPT	$27.0	$29.4	$297.3	$313.2
BAT	15.8	16.3	21.2	21.9
PSES	4.9	5.2	22.4	23.8
NSPS	24.9	76.2	24.9	76.2
PSNS	N/A	N/A	N/A	N/A
Total	$72.6	$127.1	$365.8	$435.1

N/A = Not applicable. All new sources are assumed to be direct dischargers.

[1] Does not include the costs of water pollution controls installed by the industry but not required by the final regulations.

[2] Facilities in-place as of 6/30/81.

[3] Includes operation and maintenance costs and capital costs based on a 8.99 percent capital recovery factor.

[4] Total annual costs include annual costs on pollution control facilities in place as of 6/30/81.

Exhibit E-29

STEEL INDUSTRY
EFFLUENT REGULATION COSTS

SCENARIO 2

(millions of 1980 dollars)

	Capital Costs[1]		
	Facilities In Place[2]	Facilities Required 1981-1990	Total
BPT	$1,771.6	$213.2	$1,984.8
BAT	26.4	70.1	96.5
PSES	116.8	26.3	143.1
NSPS	0	273.2	273.2
PSNS	N/A	N/A	N/A
Total	$1,914.8	$582.8	$2,497.6

	Annual Costs[3]			
	Incremental		Total[4]	
	1984	1990	1984	1990
BPT	$28.7	$27.2	$305.4	$298.1
BAT	15.5	15.9	20.7	21.2
PSES	4.9	4.9	22.7	22.9
NSPS	27.4	51.0	27.4	51.0
PSNS	N/A	N/A	N/A	N/A
Total	$76.5	$99.0	$376.2	$393.2

N/A = Not applicable. All new sources are assumed to be direct dischargers.

[1] Does not include the costs of water pollution controls installed by the industry but not required by the final regulations.

[2] Facilities in-place as of 6/30/81.

[3] Includes operation and maintenance costs and capital costs based on a 8.99 percent capital recovery factor.

[4] Total annual costs include annual costs on pollution control facilities in place as of 6/30/81.

Exhibit E-3

SHORT-RUN FINANCIAL IMPACT OF ENVIRONMENTAL REGULATIONS[1]

SCENARIO I SHIPMENTS PROJECTIONS

1980-1985

(1980 dollars in millions)

	Pollution Control and New Production Equipment Expenditures		Expenditures On Existing Equipment[2]		External Financing Needs[3]		1985 Operations and Maintenance Expenses[4]		1985 Revenue Requirements	
	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline
Iron and Steel Production	$8,640.5	78.8%	$7,475.7	114.4%	$4,010.0	116.7%	$41,459.6	97.7%	$48,885.8	96.7%
Miscellaneous Pollution Control Equipment[5]	106.5	1.0	-175.2	-2.7	-140.5	-4.1	133.9	0.3	187.5	0.4
Air Pollution Control Equipment[6]										
In-Place	1,267.7	11.5	-348.3	-5.3	-447.9	-13.9	581.9	1.4	1,009.9	2.0
Additions	631.6	5.8	-725.6	-11.1	38.3	1.1	115.9	0.3	254.2	0.5
Water Pollution Control Equipment[6]										
Pollution Controls In-Place But Not Required	11.2	0.1	12.4	0.2	0.0	0.0	9.1	0.0	12.7	0.0
BPT In-Place	230.9	2.1	310.8	4.8	10.5	0.3	114.5	0.3	195.5	0.4
BAT In-Place	7.3	0.1	6.5	0.1	-0.2	0.0	1.4	0.0	11.3	0.0
PSES In-Place	61.3	0.6	-24.7	-0.4	-3.0	-0.1	8.5	0.0	8.0	0.0
Total Baseline Conditions	$10,957.0	100.0%	$6,531.6	100.0%	$3,438.0	100.0%	$42,424.8	100.0%	$50,564.9	100.0%
Water Pollution Control Additions										
BPT Additions	213.2	1.9	-203.7	-3.1	22.7	0.7	0.4	0.0	53.0	0.1
BAT Additions	70.1	0.6	-75.7	-1.2	-1.1	0.0	6.8	0.0	25.8	0.1
PSES Additions	26.3	0.2	-25.6	-0.4	3.2	0.1	2.0	0.0	7.1	0.0
NSPS Additions	153.5	1.4	-200.4	-3.1	7.1	0.2	8.3	0.0	39.2	0.1
Total Water Pollution Control Equipment Additions	$ 463.1	4.1%	$ -505.4	-7.8%	$ 31.8	0.9%	$ 17.5	0.0%	$ 125.1	0.3%
Grand Total	$11,420.1	104.1%	$6,026.2	92.2%	$3,469.8	100.9%	$42,442.3	100.0%	$50,690.0	100.3%

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[1] Assumes full pass-through of annual water pollution control costs.

[2] Compared with a desired level of expenditures (in millions) of $11,411.6. Declines in capital expenditures on existing equipment result from constraints on industry capital availability.

[3] In some cases, the external financing needs are more than offset by cash flow from pollution control equipment investments made in prior years.

[4] Includes cost savings resulting from closing inefficient plants.

[5] Includes the cost of air pollution controls for industrial boilers at steel plants.

[6] Includes in-place equipment installed in 1980-1981. Prior to 1980, the following equipment was in place (millions of dollars):

Air pollution controls	$3,117.2
Water pollution controls not required	101.5
BPT	1,540.7
BAT	19.1
PSES	55.5

Source: IHS analysis.

Exhibit E-4

MAXIMUM SHORT-RUN ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS[1]

SCENARIO I SHIPMENTS PROJECTIONS

1985

	Price		Capacity Decline 1980-1985		Production[2]		Market Share (percent)	Employment	
	$/Ton	Percentage of Baseline	Millions of tons	Percentage of Baseline	Millions of tons	Percentage of Baseline		Thousands of Employees	Percentage of Baseline
Iron and Steel Production	$516.13	96.7%	4.44	64.2%	101.32	102.6%	79.27%	427.00	100.5%
Miscellaneous Pollution Control Equipment[3]	1.98	0.4	0.20	2.9	-0.22	-0.2	-0.16	0.71	0.2
Air Pollution Control Equipment[4]									
In-Place	10.66	2.0	1.50	21.7	-1.56	-1.6	-1.23	-2.14	-0.5
Additions	2.69	0.5	0.83	12.0	-0.83	-0.8	-0.65	-2.62	-0.6
Water Pollution Control Equipment[4]									
Pollution Controls In-Place But Not Required	0.13	0.0	-0.01	-0.1	0.01	0.0	0.01	0.16	0.0
BPT In-Place	2.06	0.4	-0.14	-2.0	0.14	0.1	0.11	2.17	0.5
BAT In-Place	0.12	0.0	0.00	0.0	0.00	0.0	0.00	0.02	0.0
PSES In-Place	0.09	0.0	0.09	1.3	-0.09	-0.1	-0.07	-0.32	-0.1
Total Baseline Conditions	$533.86	100.0%	6.91	100.0%	98.77	100.0%	77.28%	425.78	100.0%
Water Pollution Control Additions									
BPT Additions	0.56	0.1	0.27	4.0	-0.27	-0.3	-0.21	-0.90	-0.2
BAT Additions	0.27	0.1	0.10	1.4	-0.10	-0.1	-0.08	-0.35	-0.1
PSES Additions	0.08	0.0	0.03	0.4	-0.03	0.0	-0.02	-0.12	0.0
NSPS Additions	0.41	0.1	0.22	3.2	-0.22	-0.2	-0.17	-0.81	-0.2
Total Water Pollution Control Equipment Additions	$ 1.32	0.3%	0.62	9.0%	-0.62	-0.6%	-0.48%	-2.18	-0.5%
Grand Total	$535.18	100.3%	7.53	109.0%	98.15	99.4%	76.80%	423.60	99.5%

[1] Assumes full pass-through of annual water pollution control costs.

[2] In millions of tons of finished steel products.

[3] Includes the cost of air pollution controls for industrial boilers at steel plants.

[4] Includes in-place equipment installed in 1980-1981. Prior to 1980, the following equipment was in place (millions of dollars):

Air pollution controls	$3,117.2
Water pollution controls not required	101.5
BPT	1,540.7
BAT	19.1
PSES	55.5

Source: TBS analysis.

Exhibit E-5

LONG-RUN FINANCIAL IMPACT OF ENVIRONMENTAL REGULATIONS[1]

SCENARIO I SHIPMENTS PROJECTIONS

1980-1990

(1980 dollars in millions)

	Pollution Control and New Production Equipment Expenditures		Expenditures On Existing Equipment[2]		External Financing Needs[3]		1990 Operations and Maintenance Expenses[4]		1990 Revenue Requirements	
	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline
Iron and Steel Production	$12,873.4	83.8%	$19,227.4	103.5%	$11,006.2	113.1%	$47,612.4	97.7%	$55,390.9	97.3%
Miscellaneous Pollution Control Equipment[5]	106.5	0.7	-156.0	-0.8	-189.0	-1.9	153.1	0.3	197.2	0.3
Air Pollution Control Equipment[6]										
In-Place	1,267.7	8.2	-159.3	-0.9	-913.6	-9.4	608.8	1.3	897.1	1.6
Additions	809.7	5.3	-709.7	-3.8	-49.3	-0.5	175.3	0.4	338.2	0.6
Water Pollution Control Equipment[6]										
Pollution Controls In-Place But Not Required	11.2	0.1	14.7	0.1	-5.8	-0.1	9.6	0.0	9.8	0.0
BPT In-Place	230.9	1.5	366.0	2.0	-127.5	-1.3	129.9	0.3	135.9	0.2
BAT In-Place	7.3	0.0	5.6	0.0	-6.6	-0.1	3.1	0.0	4.3	0.0
PSES In-Place	61.3	0.4	-21.4	-0.1	22.4	0.2	10.9	0.0	-11.3	0.0
Total Baseline Conditions	$15,368.0	100.0%	$18,566.5	100.0%	$ 9,736.8	100.0%	$48,703.1	100.0%	$56,962.1	100.0%
Water Pollution Control Additions										
BPT Additions	213.2	1.4	0.0	0.0	64.5	0.7	2.6	0.0	117.0	0.2
BAT Additions	70.1	0.5	0.0	0.0	30.0	0.3	8.0	0.0	40.2	0.1
PSES Additions	26.3	0.2	0.0	0.0	16.8	0.2	2.8	0.0	9.7	0.0
NSPS Additions	420.5	2.7	0.0	0.0	290.7	2.9	33.9	0.1	164.9	0.3
Total Water Pollution Control Equipment Additions	$ 730.1	4.0%	$ 0.0	0.0%	$ 402.0	4.1%	$ 47.3	0.1%	$ 331.8	0.6%
Grand Total	$16,098.1	104.8%	$18,566.5	100.0%	$10,138.8	104.1%	$48,750.4	100.1%	$57,293.0	100.6%

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[1] Assumes full pass-through of annual water pollution control costs.
[2] Declines in capital expenditures on existing equipment result from constraints on industry capital availability.
[3] In some cases, the external financing needs are more than offset by cash flow from pollution control equipment investments made in prior years.
[4] Includes cost savings resulting from closing inefficient plants.
[5] Includes the cost of air pollution controls for industrial boilers at steel plants.
[6] Includes in-place equipment installed in 1980-1981. Prior to 1980, the following equipment was in place (millions of dollars):

Air pollution controls	$3,117.2
Water pollution controls not required	101.5
BPT	1,340.7
BAT	19.1
PSES	55.5

Source: ICF analysis.

Exhibit E-6

LONG-RUN ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS[1]

SCENARIO I SHIPMENTS PROJECTIONS

1990

	Price		Capacity Decline 1980-1990		Production[2]		Market Share (percent)	Employment	
	$/Ton	Percentage of Baseline	Millions of Tons	Percentage of Baseline	Millions of Tons	Percentage of Baseline		Thousands of Employees	Percentage of Baseline
Iron and Steel Production	$545.39	97.3%	0.0	0.0%	116.0	100.0%	84.5%	449.39	97.9%
Miscellaneous Pollution Control Equipment[3]	1.94	0.3	0.0	0.0	0.0	0.0	0.0	1.71	0.4
Air Pollution Control Equipment[4]									
In-Place	8.80	1.6	0.0	0.0	0.0	0.0	0.0	4.60	1.0
Additions	3.31	0.6	0.0	0.0	0.0	0.0	0.0	1.32	0.3
Water Pollution Control Equipment[4]									
Pollution Controls In-Place But Not Required	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.12	0.0
BPT In-Place	1.33	0.2	0.0	0.0	0.0	0.0	0.0	1.65	0.4
BAT In-Place	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.0
PSES In-Place	-0.12	0.0	0.0	0.0	0.0	0.0	0.0	0.10	0.0
Total Baseline Conditions	$558.80	100.0%	0.0	0.0%	116.0	100.0%	84.5%	459.11	100.0%
Water Pollution Control Additions									
BPT Additions	1.16	0.2	0.0	0.0	0.0	0.0	0.0	0.26	0.1
BAT Additions	0.39	0.1	0.0	0.0	0.0	0.0	0.0	0.06	0.0
PSES Additions	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.0
NSPS Additions	1.61	0.3	0.0	0.0	0.0	0.0	0.0	0.50	0.1
Total Water Pollution Control Equipment Additions	$ 3.26	0.6%	0.0	0.0	0.0	0.0	0.0	0.85	0.2%
Grand Total	$562.06	100.6%	0.0	0.0%	116.0	100.0%	84.5%	459.96	100.2%

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[1] Assumes full pass-through of annual water pollution control costs.

[2] In millions of tons of finished steel products.

[3] Includes the cost of air pollution controls for industrial boilers at steel plants.

[4] Includes in-place equipment installed in 1980-1981. Prior to 1980, the following equipment was in place (millions of dollars):

Air pollution controls	$3,117.2
Water pollution controls not required	101.5
BPT	1,540.7
BAT	19.1
PSES	55.5

Source: TBS analysis.

Exhibit E-7

SHORT-RUN FINANCIAL IMPACT OF ENVIRONMENTAL REGULATIONS[1]

SCENARIO 2 SHIPMENTS PROJECTIONS

1980-1985

(1980 dollars in millions)

	Pollution Control and New Production Equipment Expenditures		Expenditures On Existing Equipment[2]		External Financing Needs[3]		1985 Operations and Maintenance Expenses[4]		1985 Revenue Requirements	
	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline
Iron and Steel Production	$8,602.8	79.0%	$8,149.0	112.5%	$3,829.8	118.7%	$39,920.8	97.8%	$46,650.8	96.8%
Miscellaneous Pollution Control Equipment[5]	81.1	0.7	-152.2	-2.1	-141.7	-4.4	125.8	0.3	160.5	0.3
Air Pollution Control Equipment[6]										
In-Place	1,267.6	11.6	-374.7	-5.2	-503.0	-15.6	541.9	1.3	958.0	2.0
Additions	631.6	5.8	-680.8	-9.4	29.1	0.9	108.5	0.3	242.2	0.5
Water Pollution Control Equipment[6]										
Pollution Controls In-Place But Not Required	11.3	0.1	14.0	0.2	1.2	0.0	8.4	0.0	12.9	0.0
BPT In-Place	230.9	2.1	306.0	4.2	8.4	0.3	115.2	0.3	201.1	0.4
BAT In-Place	7.2	0.1	1.6	0.0	-0.2	0.0	2.7	0.0	4.7	0.0
PSES In-Place	61.4	0.6	-11.7	-0.2	3.9	0.1	5.3	0.0	21.1	0.0
Total Baseline Conditions	$10,893.9	100.0%	$7,251.2	100.0%	$3,227.5	100.0%	$40,828.6	100.0%	$48,259.3	100.0%
Water Pollution Control Additions										
BPT Additions	213.2	2.0	-221.4	-3.1	11.2	0.3	3.3	0.0	46.3	0.1
BAT Additions	70.1	0.6	-75.7	-1.0	0.8	0.0	6.8	0.0	23.0	0.0
PSES Additions	26.3	0.2	-26.4	-0.4	2.8	0.1	1.9	0.0	7.1	0.0
NSPS Additions	153.3	1.4	-170.9	-2.4	6.4	0.2	11.2	0.1	41.6	0.1
Total Water Pollution Control Equipment Additions	$ 462.9	4.2%	$ -494.4	-6.9%	$ 21.2	0.6%	$ 23.2	0.1%	$ 118.0	0.2%
Grand Total	$11,356.8	104.2%	$6,756.8	93.1%	$3,248.7	100.6%	$40,851.8	100.1%	$48,377.3	100.2%

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[1] Assumes full pass-through of annual water pollution control costs.

[2] Compared with a desired level of expenditures (in millions) of $11,411.6. Declines in capital expenditures on existing equipment result from constraints on industry capital availability.

[3] In some cases, the external financing needs are more than offset by cash flow from pollution control equipment investments made in prior years.

[4] Includes cost savings resulting from closing inefficient plants.

[5] Includes the cost of air pollution controls for industrial boilers at steel plants.

[6] Includes in-place equipment installed in 1980-1981. Prior to 1980, the following equipment was in place (millions of dollars):

Air pollution controls	$3,117.2
Water pollution controls not required	101.5
BPT	1,540.7
BAT	19.1
PSES	55.5

Source: IHS projections.

E-25

Exhibit E-8

MAXIMUM SHORT-RUN FINANCIAL IMPACT OF ENVIRONMENTAL REGULATIONS[1]

SCENARIO 2 SHIPMENTS PROJECTIONS

1985

	Price		Capacity Decline 1980-1985		Production[2]		Market Share (percent)	Employment	
	$/Ton	Percentage of Baseline	Millions of Tons	Percentage of Baseline	Millions of Tons	Percentage of Baseline		Thousands of Employees	Percentage of Baseline
Iron and Steel Production	$515.44	96.8%	3.55	59.4%	103.20	102.0%	84.50%	448.46	100.0%
Miscellaneous Pollution Control Equipment[3]	1.86	0.3	0.15	2.5	0.00	0.0	0.00	1.60	0.4
Air Pollution Control Equipment[4]									
In-Place	10.59	2.0	1.50	25.1	-1.13	-1.1	-0.93	-0.42	-0.1
Additions	2.68	0.5	0.81	13.6	-0.91	-0.9	-0.74	-3.05	-0.7
Water Pollution Control Equipment[4]									
Pollution Controls In-Place But Not Required	0.14	0.0	0.00	0.0	0.01	0.0	0.01	0.17	0.0
BPT In-Place	2.22	0.4	-0.14	-2.3	0.14	0.1	0.12	2.25	0.5
BAT In-Place	0.05	0.0	0.01	0.2	0.00	0.0	-0.01	-0.01	0.0
PSES In-Place	0.25	0.0	0.09	1.5	-0.10	-0.1	-0.08	-0.33	-0.1
Total Baseline Conditions	$533.21	100.0%	5.97	100.0%	101.21	100.0%	82.87%	448.67	100.0%
Water Pollution Control Additions									
BPT Additions	0.52	0.1	0.28	4.7	-0.31	-0.3	-0.25	-1.11	-0.2
BAT Additions	0.25	0.0	0.09	1.5	-0.10	-0.1	-0.09	-0.40	-0.1
PSES Additions	0.08	0.0	0.04	0.7	-0.04	0.0	-0.03	-0.14	0.0
NSPS Additions	0.46	0.1	0.20	3.4	-0.22	-0.2	-0.18	-0.82	-0.2
Total Water Pollution Control Equipment Additions	$ 1.31	0.2%	0.61	10.3%	-0.67	-0.6%	-0.55%	-2.47	-0.5%
Grand Total	$534.52	100.2%	6.58	110.3%	100.54	99.4%	82.32%	446.20	99.5%

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[1] Assumes full pass-through of annual water pollution control costs.

[2] In millions of tons of finished steel products.

[3] Includes the cost of air pollution controls for industrial boilers of steel plants.

[4] Includes in-place equipment installed in 1980-1981. Prior to 1980, the following equipment was in place (millions of dollars):

Air pollution controls	$3,117.2
Water pollution controls not required	101.5
BPT	1,540.7
BAT	19.1
PSES	55.5

Source: IHS projections.

E-26

Exhibit E-9

LONG-RUN FINANCIAL IMPACT OF ENVIRONMENTAL REGULATIONS[1]

SCENARIO 2 SHIPMENTS PROJECTIONS

1980-1990

(1980 dollars in millions)

	Pollution Control and New Production Equipment Expenditures		Expenditures On Existing Equipment[2]		External Financing Needs[3]		1990 Operations and Maintenance Expenses[4]		1990 Revenue Requirements	
	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline
Iron and Steel Production	$10,357.1	81.5%	$17,208.7	97.6%	$5,826.6	108.2%	$44,372.1	97.9%	$51,343.9	97.2%
Miscellaneous Pollution Control Equipment[5]	81.1	0.6	-76.4	-0.4	-126.9	-2.4	142.8	0.3	179.0	0.3
Air Pollution Control Equipment[6]										
In-Place	1,267.6	10.0	426.6	2.4	-391.0	-7.3	593.7	1.3	888.4	1.7
Additions	688.7	5.4	-476.6	-2.7	87.6	1.6	134.1	0.3	259.2	0.5
Water Pollution Control Equipment[6]										
Pollution Controls In-Place But Not Required	11.3	0.1	22.5	0.1	-5.1	-0.1	8.9	0.0	14.1	0.0
BPT In-Place	230.9	1.8	516.2	2.9	-12.9	-0.2	112.6	0.2	137.2	0.3
BAT In-Place	7.2	0.1	4.8	0.0	0.4	0.0	2.9	0.0	3.9	0.0
PSES In-Place	61.4	0.5	18.0	0.1	9.3	0.2	5.8	0.0	19.4	0.0
Total Baseline Conditions	$12,705.3	100.0%	$17,643.8	100.0%	$5,388.0	100.0%	$45,372.9	100.0%	$52,845.1	100.0%
Water Pollution Control Additions										
BPT Additions	213.2	1.7	-125.9	-0.7	29.9	0.6	3.5	0.0	37.8	0.1
BAT Additions	70.1	0.6	-44.2	-0.3	6.9	0.1	7.7	0.0	20.3	0.0
PSES Additions	26.3	0.2	-17.8	-0.1	4.0	0.1	2.1	0.0	2.6	0.0
NSPS Additions	273.2	2.2	-208.6	-1.2	25.1	0.5	23.2	0.1	76.7	0.1
Total Water Pollution Control Equipment Additions	$ 582.8	4.7%	$ -396.5	-2.3%	$ 65.9	1.3%	$ 36.5	0.1%	$ 137.4	0.2%
Grand Total	$13,288.1	104.7%	$17,247.3	97.7%	$5,453.9	101.3%	$45,409.4	100.1%	$52,982.5	100.2%

[1] Assumes full pass-through of annual water pollution control costs.
[2] Declines in capital expenditures on existing equipment result from constraints on industry capital availability.
[3] In some cases, the external financing needs are more than offset by cash flow from pollution control equipment investments made in prior years.
[4] Includes cost savings resulting from closing inefficient plants.
[5] Includes the cost of air pollution controls for industrial boilers at steel plants.
[6] Includes in-place equipment installed in 1980-1981. Prior to 1980, the following equipment was in place (millions of dollars):

Air pollution controls	$3,117.2
Water pollution controls not required	101.5
BPT	1,540.7
BAT	19.1
PSES	55.5

Source: IOS projections.

Exhibit E-10

LONG-RUN ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS[1]

SCENARIO 2 SHIPMENTS PROJECTIONS

1990

	Price		Capacity Decline 1980-1990		Production[2]		Market Share (percent)	Employment	
	$/Ton	Percentage of Baseline	Millions of Tons	Percentage of Baseline	Millions of Tons	Percentage of Baseline		Thousands of Employees	Percentage of Baseline
Iron and Steel Production	$539.50	97.2%	2.79	94.1%	103.60	100.1%	80.83%	394.03	98.2%
Miscellaneous Pollution Control Equipment[3]	1.08	0.3	0.04	1.3	-0.05	0.0	-0.04	1.35	0.3
Air Pollution Control Equipment[4]									
In-Place	9.34	1.7	0.14	4.7	-0.16	-0.2	-0.12	3.66	0.9
Additions	2.72	0.5	0.42	14.1	-0.46	-0.4	-0.36	-0.72	-0.2
Water Pollution Control Equipment[4]									
Pollution Controls In-Place But Not Required	0.15	0.0	-0.02	-0.7	0.02	0.0	0.02	0.20	0.0
BPT In-Place	1.44	0.3	-0.44	-14.8	0.49	0.5	0.38	3.41	0.8
BAT In-Place	0.04	0.0	0.01	0.3	-0.01	0.0	-0.01	-0.01	0.0
PSES In-Place	0.21	0.0	0.03	1.0	-0.04	0.0	-0.03	-0.06	0.0
Total Baseline Conditions	$535.28	100.0%	2.97	100.0%	103.39	100.0%	80.67%	401.06	100.0%
Water Pollution Control Additions									
BPT Additions	0.39	0.1	0.10	3.4	-0.11	-0.1	-0.09	-0.19	0.0
BAT Additions	0.22	0.0	0.04	1.3	-0.04	0.0	-0.03	-0.11	0.0
PSES Additions	0.02	0.0	0.02	0.7	-0.02	0.0	0.01	-0.05	0.0
NSPS Additions	0.81	0.1	0.25	8.4	-0.27	-0.3	-0.21	-0.73	-0.2
Total Water Pollution Control Equipment Additions	$ 1.44	0.2%	0.41	13.8%	-0.44	-0.4%	-0.34%	-1.08	-0.2%
Grand Total	$556.72	100.2%	3.38	113.8%	102.95	99.6%	80.33%	400.78	99.8%

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[1] Assumes full pass-through of annual water pollution control costs.

[2] In millions of tons of finished steel products.

[3] Includes the cost of air pollution controls for industrial boilers at steel plants.

[4] Includes in-place equipment installed in 1980-1981. Prior to 1980, the following equipment was in place (millions of dollars):

Air pollution controls	$3,117.2
Water pollution controls not required	101.5
BPT	1,540.7
BAT	19.1
PSES	55.5

Source: TBS projections.

Exhibit E-11

SENSITIVITY ANALYSIS ON SCENARIO I
SHORT-RUN FINANCIAL IMPACT OF ENVIRONMENTAL REGULATIONS

1980-1985

(1980 dollars in millions)

	Pollution Control and New Production Equipment Expenditures		Expenditures on Existing Equipment		External Financing[1]		1985 Operations and Maintenance[2]		1985 Revenue Requirements	
	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline
Scenario I										
Baseline	$10,957.0	100.0%	$6,531.6	100.0%	$3,438.0	100.0%	$42,424.8	100.0%	$50,564.9	100.0%
Water Pollution Control Additions	463.1	4.2	-505.4	-7.7	31.8	0.9	17.5	0.0	125.1	0.2
Baseline with Water Pollution Control Additions	11,420.1	104.2%	6,026.2	92.3%	3,469.8	100.9%	42,442.3	100.0%	50,690.0	100.2%
Sensitivity 1 - DRI Inflation										
Baseline	10,954.5	100.0%	6,779.6	103.8%	3,772.1	109.7%	40,652.8	95.8%	49,530.2	98.0%
Water Pollution Control Additions	462.7	4.2	-533.1	-8.2	23.5	0.7	20.5	0.0	114.5	0.2
Baseline with Water Pollution Control Additions	11,417.2	104.2%	6,246.5	95.6%	3,795.6	110.4%	40,673.3	95.8%	49,644.7	98.2%
Sensitivity 2 - Double Water Costs										
Baseline	11,267.9	102.8%	6,889.5	105.5%	3,462.4	100.7%	42,425.4	100.0%	50,676.6	100.2%
Water Pollution Control Additions	926.1	8.5	-1,030.4	-15.8	45.1	1.3	5.7	0.0	201.9	0.4
Baseline with Water Pollution Control Additions	12,194.0	111.3%	5,859.1	89.7%	3,507.5	102.0%	42,431.1	100.0%	50,878.5	100.6%
Sensitivity 3 - Air Stretchout										
Baseline	10,848.6	99.0%	6,504.8	99.6%	3,424.0	99.6%	42,425.2	100.0%	50,469.5	99.8%
Water Pollution Control Additions	463.1	4.2	-517.1	-7.9	24.3	0.7	19.2	0.0	117.0	0.2
Baseline with Water Pollution Control Additions	11,311.7	103.2%	5,987.7	91.7%	3,448.3	100.3%	42,444.4	100.0%	50,586.5	100.0%
Sensitivity 4 - 100% Cost Savings Pass-Through										
Baseline	10,957.0	100.0%	7,875.5	120.6%	3,901.0	113.5%	42,445.6	100.0%	51,649.0	102.1%
Water Pollution Control Additions	463.1	4.2	-464.4	-7.1	47.3	1.4	22.3	0.1	167.3	0.3
Baseline with Water Pollution Control Additions	11,420.1	104.2%	7,411.1	113.5%	3,948.3	114.9%	42,467.9	100.1%	51,816.3	102.4%

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[1] In some cases the external financing needs are more than offset by cash flow from pollution control equipment investments made in prior years.

[2] Includes cost savings resulting from closing inefficient plants.

Source: TBS analysis.

Exhibit E-12

SENSITIVITY ANALYSIS ON SCENARIO I
SHORT-RUN ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS

1985

	Price		Capacity Decline		Production		Market Share (percent)	Employment	
	$/Ton	Percentage of Baseline	Millions of Tons	Percentage of Baseline	Millions of Tons	Percentage of Baseline		Thousands of Employees	Percentage of Baseline
Scenario I									
Baseline	$533.86	100.0%	6.91	100.0%	98.77	100.0%	77.28%	425.78	100.0%
Water Pollution Control Additions	1.32	0.2	.62	9.0	-0.62	-0.6	-0.48	-2.18	-0.5
Baseline with Water Pollution Control Additions	535.18	100.2%	7.53	109.0%	98.15	99.4%	76.80%	423.60	99.5%
Sensitivity 1 - DRI Inflation									
Baseline	$522.93	98.0%	5.95	86.1%	99.74	101.0%	78.04%	429.97	101.0%
Water Pollution Control Additions	1.21	0.2	0.59	8.5	-0.60	-0.6	-0.47	-2.10	-0.5
Baseline with Water Pollution Control Additions	524.14	98.2%	6.54	94.6%	99.14	100.4%	77.57%	427.87	100.5%
Sensitivity 2 - Double Water Costs									
Baseline	$535.04	100.2%	6.82	98.7%	98.86	100.1%	77.35%	426.19	100.1%
Water Pollution Control Additions	2.13	0.4	1.24	17.9	-1.23	-1.2	-0.96	-4.84	-1.1
Baseline with Water Pollution Control Additions	537.17	100.6%	8.06	116.6%	97.63	98.8%	76.39%	421.35	99.0%
Sensitivity 3 - Air Stretchout									
Baseline	$532.85	99.8%	6.79	98.3%	98.89	100.1%	77.37%	426.31	100.1%
Water Pollution Control Additions	1.24	0.2	0.62	9.0	-0.62	-0.6	-0.48	-2.21	-0.5
Baseline with Water Pollution Control Additions	534.09	100.0%	7.41	107.3%	98.27	99.5%	76.89%	424.10	99.5%
Sensitivity 4 - 100% Cost Savings Pass-Through									
Baseline	$545.30	102.1%	5.77	83.5%	99.93	101.2%	78.19%	430.80	101.2%
Water Pollution Control Additions	1.77	0.3	0.57	8.2	-0.59	-0.6	-0.46	-2.07	-0.5
Baseline with Water Pollution Control Additions	547.07	102.4%	6.34	91.8%	99.34	100.6%	77.73%	428.73	100.7%

Source: TBS analysis.

Exhibit E-13

SENSITIVITY ANALYSIS ON SCENARIO 1
LONG-RUN FINANCIAL IMPACT OF ENVIRONMENTAL REGULATIONS

1980-1990

(1980 dollars in millions)

	Pollution Control and New Production Equipment Expenditures		Expenditures on Existing Equipment		External Financing[1]		1990 Operations and Maintenance[2]		1990 Revenue Requirements	
	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline	Amount	Percentage of Baseline
Scenario 1										
Baseline	$15,368.0	100.0%	$18,386.5	100.0%	$ 9,736.8	100.0%	$48,703.1	100.0%	$56,962.1	100.0%
Water Pollution Control Additions	730.1	4.8	0.0	0.0	402.0	4.1	47.3	0.1	331.8	0.6
Baseline with Water Pollution Control Additions	$16,098.1	104.8%	$18,386.5	100.0%	$10,138.8	104.1%	$48,750.4	100.1%	$57,293.9	100.6%
Sensitivity 1--DRI Inflation										
Baseline	$15,438.1	100.5%	$18,702.1	100.6%	$11,349.6	116.6%	$45,328.1	93.1%	$54,131.9	95.0
Water Pollution Control Additions	733.8	4.8	0.0	0.0	496.6	5.1	50.6	0.1	296.7	0.5
Baseline with Water Pollution Control Additions	$16,171.9	105.5%	$18,702.1	100.6%	$11,846.2	121.7%	$45,378.7	93.2%	$54,428.6	95.5%
Sensitivity 2--Double Water Costs										
Baseline	$15,678.9	102.0%	$19,000.2	102.2%	$ 9,551.7	98.1%	$48,703.5	100.0%	$57,011.3	100.1%
Water Pollution Control Additions	1,460.0	9.5	0.0	0.0	875.9	9.0	39.8	0.1	539.9	0.9
Baseline with Water Pollution Control Additions	$17,138.9	111.5%	$19,000.2	102.2%	$10,427.6	107.1%	$48,743.3	100.1%	$57,551.2	101.0%
Sensitivity 3--Air Stretchout										
Baseline	$15,259.6	99.3%	$18,517.9	99.6%	$ 9,652.9	99.1%	$48,697.3	100.0%	$56,987.7	100.0%
Water Pollution Control Additions	730.1	4.8	0.0	0.0	446.2	4.6	51.2	0.1	302.4	0.5
Baseline with Water Pollution Control Additions	$15,989.7	104.1%	$18,517.9	99.6%	$10,099.1	103.7%	$48,748.5	100.1%	$57,290.1	100.5%
Scenario 4--100 Percent Cost Savings Pass Through										
Baseline	$15,368.0	100.0%	$20,293.3	109.2%	$ 9,082.4	93.3%	$48,719.9	100.0%	$57,617.0	101.1%
Water Pollution Control Additions	730.1	4.8	0.0	0.0	362.7	3.7	53.2	0.1	324.8	0.6
Baseline with Water Pollution Control Additions	$16,098.1	104.8%	$20,293.3	109.2%	$ 9,445.1	97.0%	$48,773.1	100.1%	$57,941.8	101.7%

[1] In some cases the external financing needs are more than offset by cash flow from pollution control equipment investments made in other years.
[2] Includes cost savings resulting from closing inefficient plants.

Source: ICF analysis.

E-31

Exhibit E-14

SENSITIVITY ANALYSIS ON SCENARIO I
LONG-RUN ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS

1990

	Price		Capacity Decline 1980-1990		Production		Market Share (percent)	Employment	
	$/Ton	Percentage of Baseline	Millions of Tons	Percentage of Baseline	Millions of Tons	Percentage of Baseline		Thousands of Employees	Percentage of Baseline
Scenario I									
Baseline	558.80	100.0%	0.0	-	116.00	100.0%	84.50%	459.11	100.0%
Water Pollution Control Additions	3.26	0.6	0.0	-	0.00	0.0	0.0	0.85	0.2
Baseline with Water Pollution Control Additions	562.06	100.6%	0.0	-	100.0	100.0%	84.50%	459.96	100.2%
Sensitivity 1--DRI Inflation									
Baseline	531.04	95.0%	0.0	-	116.00	100.0%	84.50%	459.11	100.0%
Water Pollution Control Additions	2.92	0.5	0.0	-	0.00	0.0	0.00	0.85	0.2
Baseline with Water Pollution Control Additions	533.96	95.5%	0.0	-	116.00	100.0%	84.50%	459.96	100.2%
Sensitivity 2--Double Water Costs									
Baseline	559.29	100.1%	0.0	-	116.00	100.0%	84.50%	459.11	100.0%
Water Pollution Control Additions	5.30	0.9	0.0	-	0.00	0.0	0.00	0.85	0.2
Baseline with Water Pollution Control Additions	564.59	101.0%	0.0	-	116.00	100.0%	84.50%	459.96	100.2%
Sensitivity 3--Air Stretchout									
Baseline	559.06	100.0%	0.0	-	116.00	100.0%	84.50%	459.11	100.0%
Water Pollution Control Additions	2.96	0.5	0.0	-	0.00	0.0	0.00	0.85	0.2
Baseline with Water Pollution Control Additions	562.02	100.5%	0.0	-	116.00	100.0%	84.50%	459.96	100.2%
Sensitivity 4--100 Percent Cost Savings									
Baseline	565.23	101.1%	0.0	-	116.00	100.0%	84.50%	459.11	100.0%
Water Pollution Control Additions	3.19	0.6	0.0	-	0.00	0.0	0.00	0.85	0.2
Baseline with Water Pollution Control Additions	568.42	101.7%	0.0	-	116.00	100.0%	84.50%	459.96	100.2%

Source: IBS analysis.

I. INTRODUCTION

This report presents the results of a 36-month study conducted by Temple, Barker & Sloane, Inc. (TBS) to evaluate the economic effects of the final effluent guidelines on the iron and steel industry. The study effort was sponsored by the Office of Policy Analysis of the U.S. Environmental Protection Agency (EPA) as part of the EPA's overall review of the water pollution control regulation for the iron and steel industry.

In December 1980, TBS prepared a preliminary report entitled An Economic Analysis of Proposed Effluent Limitations Guidelines in support of the proposed water pollution control regulation to be required for this industry. The current study, which uses the same analytical approach that was used in the previous study to examine the final regulation, contains an improved evaluation of steel industry pollution control and financial characteristics. The study is intended to provide an in-depth evaluation of the total economic impact of the final effluent guidelines and other EPA regulations within the context of future uncertainties facing the steel industry.

The TBS analysis focused on the impact of the final effluent guidelines in light of the capital constraints the steel industry is likely to face during the next decade. TBS assumed that the current government policies toward the industry would continue throughout the 1980s. These policies include the current provisions of the Economic Recovery Tax Act of 1981 concerning corporate income tax rates, depreciation schedules, and investment tax credits; the relaxation of formal and informal steel price controls; and the effective enforcement of steel trade laws such as the trigger price mechanism.

In terms of approach, the analysis focused on two time periods--1980 to 1985 and 1980 to 1990--and was developed using two scenarios for the future demand for domestically produced steel products. A fairly profitable scenario with rapid growth in production (Scenario 1) was based on an American Iron and Steel Institute (AISI) projection of steel shipments of 108 million tons in 1985 and 116 million tons in 1990. This scenario would result in capacity constraints throughout most of the 1980s. A less profitable, less expansionary scenario (Scenario 2) was based on an econometric model of future industrial production, which projected shipments of 103.2 million tons in 1985 and 108.3 million tons in 1990. The second scenario would result in underutilized capacity for most of the 1980s. In addition, TBS performed sensitivity analyses to examine several of the major assumptions used in the study.

The following section describes the steel industry's performance during the last decade and thus provides a perspective for the economic analyses. The final section outlines the types of steel-related production and pollution control operations included in the analysis.

BACKGROUND

The domestic steel industry is now experiencing greater profitability and higher shipment levels than it did in 1980, despite the continued economic recession. Domestic shipments in 1981 were estimated to be about 92.0 million tons,[1] an increase of 9.6 percent over the depressed level of 83.9 million tons in 1980, when the high interest rates that curbed demand in major steel-consuming sectors, as well as the relative cost advantage of foreign steel, kept shipments at low levels. Currently, however, the benefits of modernization and cost cutting throughout the steel industry are resulting in a more effective utilization of assets and a more profitable industry. Despite continued economic uncertainty and import competition, the industry has recently announced expanded programs for modernization and replacement of production capacity.

A discussion of the industry's economic and financial condition from the boom year 1974 to the present provides the context upon which the industry's current optimism is based. An important consideration within this context is the impact that government regulation has had on the steel industry's financial performance.

In 1974, the steel industry achieved record profits. The relaxation of steel price controls during 1974 was a major factor in the industry's record performance. Perhaps just as important was the anticipation of shortages in basic raw materials, which led to a significant increase in the product inventories of steel customers and to a similar increase in domestic shipments. By the end of 1974, the steel industry was looking forward to continued strong performance over the next few years. On the basis of this optimistic outlook, steel companies planned substantial capital spending programs for modernization, replacement, and expansion of their production capacity.

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[1] Forecast as of August 1981; since that date an economic recession has reduced this estimate to about 87.0 million tons.

The economic recession of 1975, however, had a devastating effect on the steel industry. Shipments declined by more than 25 percent during that year. Moreover, the year was marked by direct confrontation over prices between the Council on Wage and Price Stability and the steel industry. Yet by year-end, the industry was once again looking ahead optimistically, though this optimism was tempered by the economic realities of an uncertain economy, foreign competition, and continued government regulation.

During 1976, steel shipments increased 11.9 percent as the steel product inventories built up in 1974 became depleted. Despite this increase in shipments, the steel industry's profitability continued to erode, with net income as a percentage of sales falling from 6.6 percent in 1974 to 3.7 percent in 1976. Return on equity during the same period decreased from 17.1 percent to 7.8 percent. The decline in the industry's profitability in large part reflected a decrease in its pricing flexibility. Steel industry prices rose by only 6.4 percent in 1976, while total industry production costs increased by a significantly higher percentage.

The steel industry's performance continued to deteriorate in 1977. Shipments increased by only 1.9 percent, and profits were minimal. Price increases were held to 9.6 percent on a list basis by domestic producers, with significant discounting relative to published prevailing prices. In spite of this pricing restraint, domestic producers experienced a market share decline as the import share of apparent steel supply rose from 14.1 percent in 1976 to 17.8 percent in 1977. Faced with a weak financial condition and strong import penetration in the domestic market, steel producers began to seriously curtail their capital spending programs for production capacity and to shut down unprofitable facilities.

The steel industry's profitability recovered somewhat in 1978. Net income as a percentage of sales was 2.6 percent, and return on equity reached 7.3 percent. This improved performance reflected a 7.5 percent increase in shipments and a 10.7 percent rise in steel prices. However, even with this improvement over the poor performance of 1977, the steel industry's earnings remained weak.

The partial recovery experienced by the steel industry in 1978 occurred within the context of two new government policies: the trigger price mechanism and the "Anti-Inflation Program." Trigger prices, instituted in February 1978 by the Carter Administration, were designed to preclude foreign steel products from being sold in the domestic market at price levels below the cost of steel produced by the Japanese, who were considered the most efficient steel producers. The trigger price mechanism was intended to replace a more cumbersome system of trade laws administered by the government and the filing of complaints by individual firms. Trigger prices helped minimize further import penetration during 1978. The import share of apparent steel supply for the year rose only slightly from the 1977 level of 17.8 percent to 18.1 percent. The second new government policy was a set of anti-inflation guidelines, instituted during the last quarter of 1978, which suggested that steel price increases be restricted to the average of steel company price increases during the two years preceding October 1978 (approximately 10.1 percent per year).

The two new government policies continued to affect the steel industry in 1979. In this year, the industry experienced a decrease in the import share of apparent steel supply, in part because of increases in trigger prices of 9.1 percent during the latter part of 1978 and 7.0 percent during the first quarter of 1979. The 1979 import share of 15.2 percent represented a 2.9 percentage point decrease from the 1978 level. A more significant factor in the decline in imports, however, was the deterioration in total demand for steel products during 1979.

The decline in total steel demand in 1979 occurred despite strong demand conditions during the first part of the year, which led to a 2.4 percent increase in domestic shipments for the year as a whole. The strong demand during the first part of the year also created significant pricing leverage for the industry, which resulted in steel prices' increasing by about 10.2 percent for the year as a whole. The increase in prices reflected the approximate 10.1 percent ceiling imposed by the Anti-Inflation Program. However, this price increase, together with the 2.4 percent rise in the volume of shipments, was not sufficient to overcome the even larger cost increases during 1979. As a result, steel industry profitability levels in 1979 were slightly lower than the 1978 earnings figures. Net income as a percentage of sales was 2.1 percent in 1979 versus 2.6 percent in 1978, and return on equity was 6.8 percent compared with 7.3 percent in 1978. These fairly weak levels of profitability exacerbated the industry's capital formation problems and caused it to maintain a reserved position in its capital spending projections for the next few years.[2]

The economic recession further entrenched the industry's pessimistic outlook in 1980, with both shipments and profitability exhibiting marked declines. The year 1980 also witnessed a change in government programs affecting the steel industry. On March 21, the Carter Administration suspended the trigger price mechanism. The suspension was the Administration's response to the filing of a complaint by the U.S. Steel Corporation that imports from Europe were being priced at below "fair value." The suspension resulted in uncertainty regarding the government's future plans in the area of steel import policy.

The economic recession continued to affect the steel industry into 1981. However, the Reagan Administration's tax cut improved hopes for a higher demand for steel products in the future and provided urgently needed cash flow to the industry. In October 1981, the Administration, promising strict enforcement of U.S. trade laws, reinstituted the trigger price mechanism and convinced U.S. Steel to drop its 1980 complaint. Since that time, the import share of domestic steel consumption has risen to above 20 percent, driven in part by a shortage in domestic capacity for tubular steel products. Currently, several steel companies are readying cases for future import complaints.

Despite the apparent constraints, steel companies, many of which are led by new management teams, appear to see a brighter future. The highly publicized diversification of steel companies into nonsteel areas has taken attention away from recent announcements of the largest capital expenditure programs since the early 1970s. Most of these expenditures will be allocated for mills to produce new steel products and for continuous casters to improve the cost and productivity of steel production. The breakeven utilization rate of steel facilities is reported to have decreased well below the historical 85 percent. This decrease indicates that the positive effects of rationalization of facilities--modernization of existing capacity and closure of outdated capacity--were felt in 1981.

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[2] American Iron and Steel Institute, Steel at the Crossroads: The American Steel Industry in the 1980s, January 1980, pp. 39-40.

The industry itself and many of its analysts are expecting capacity constraints to begin in the steel industry in the middle to late 1980s. The degree of severity of these constraints and the uncertain time frame in which they will occur are the primary factors affecting the analysis described in this report.

SCOPE OF THE STUDY

In this study, the steel industry was defined as those production process units normally associated with steel production and finishing--the on-site production facilities, from raw materials storage yards for coke ovens and blast furnaces to finishing mills.[3] Thus, both facilities for the mining, beneficiation, and transportation of raw materials to the site of coking and ironmaking and fabrication facilities were excluded from the definition of the steel industry. However, facilities used by the steel industry to produce pig iron for foundries and other uses were included. All other nonsteel operations performed by steel firms were excluded from the impact analysis reviewed in this report.

The American Iron and Steel Institute (AISI) provided TBS with detailed operating data on 100 steel plants. The data had been developed for a cost impact study conducted for the AISI by Arthur D. Little (ADL).[4] In order to utilize the data most effectively, TBS limited its analysis to the steelmaking and finishing facilities that produced approximately 87.7 percent of domestic steel shipments. While extrapolations to total steel operations could be made, extension of the analysis to include iron ore and coal mining, beneficiation, transportation, fabrication, and other nonsteel operations performed by steel companies would not be appropriate.

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[3] Utilizing data provided by the American Iron and Steel Institute, TBS estimated that steel operations so defined represented about 68 percent of the net fixed assets of the major integrated steel companies during the 1972-1978 period. If iron ore, metallurgical coal, and scrap had been transferred at market values, sales revenues from steel operations would have approximated 79 percent of the total revenues of these firms during this period.

[4] Arthur D. Little, Steel and the Environment: A Cost Impact Analysis, American Iron and Steel Institute, 1978.

The four chapters that follow outline the methodology, results, and conclusions developed in TBS's analysis. Chapter II describes the baseline condition of the industry. The cost, financial, and economic impacts of the final water regulation are delineated in Chapters III, IV, and V. Finally, the research methodology is discussed in an Appendix.

II. BASELINE CONDITION

In order to evaluate the economic impact of the final water pollution control regulation on the iron and steel industry, it was first necessary to establish a reference point, or baseline condition, that described the industry's future operating and financial characteristics without the costs of the final regulation. This baseline condition was established by determining the capital and expenses needed to produce a projected volume of finished steel products under the current pollution control regulations through the aid of PTm(Steel), TBS's policy-testing model for the steel industry.

To estimate future conditions in the iron and steel industry, TBS collected information from a number of industry, government, academic, and financial sources. These sources, specifically noted in the sections that follow, include the EPA and its technical consultants in the iron and steel industry area, PEDCo Environmental, Inc. (PEDCo) and the NUS Corporation, Cyrus Wm. Rice Division (NUS/Rice), and the AISI and its consultant, Arthur D. Little, Inc. (ADL).

The following specific tasks were performed to establish the baseline description of the iron and steel industry:

- Future steel shipments were projected.
- Future operations and maintenance (O&M) expenses for iron and steel production were determined using PTm(Steel).
- Future profitability and future capital constraints were projected, and their influences on the funds available for capital expenditures were evaluated.
- Future capacity retirements were projected.
- Future capital outlays for new production capacity were estimated, taking into account projected capacity constraints.
- Future capital expenditures on existing equipments were estimated, taking into account financial constraints and past requirements for such expenditures.

- Future capital expenditures and O&M expenses for currently installed air and water pollution control equipment were estimated using technical data provided by the EPA in conjunction with PTm(Steel). The impact of in-place pollution controls on capital expenditures for existing equipment, which resulted from the financial constraints, was also considered.

The sections that follow describe each of these tasks.

FUTURE STEEL SHIPMENTS

Future domestic steel shipments, an important consideration in the steel industry's future, are a vital element in the evaluations in PTm(Steel). The shipments estimate determines the required level of production for each production process in the model, thereby establishing process O&M expenses, capacity utilization rates, and capacity addition needs.

For a number of reasons, estimates of future domestic steel shipments are subject to uncertainty. Variations in the business cycle can cause wide fluctuations in the short-term consumption of steel, often masking the underlying level of demand. This is especially true considering today's recessionary economy. For example, high interest rates have reduced the demand for the products of steel consumers (such as automobile manufacturers, construction firms, and equipment manufacturers) while limited capacity has not allowed the steel industry to meet the current booming demand in the energy sector. There is also uncertainty with respect to the long-term demand for steel. The post-World War II growth rate in domestic shipments obtained from a time-series regression analysis has been about 1.2 percent per year. However, the long-term effects of high oil prices on steel consumption, combined with the reduction of steel content in automobiles, shifts in sectoral demand, continued economic fluctuations, and foreign competition, make projecting future shipment levels difficult.

Because of the major uncertainty surrounding steel shipments, TBS prepared two likely scenarios for the future demand for steel. In preparing the shipments forecasts, TBS assumed a base domestic apparent consumption of steel products of approximately 109 million tons in 1981 in both scenarios. The share of imports was assumed to be 15.5 percent, which resulted in domestic steel shipments of 92 million tons[1] in 1981.

The shipments in Scenario 1 were based on forecasts presented in the ADL report to the AISI: Environmental Policy for the 1980s: Impact on the American Steel Industry (1980). To develop Scenario 2 shipment estimates, TBS used production indices obtained from Data Resources, Inc. (DRI) and adjusted them to reflect the effects of automobile downsizing (a reduction in steel demand of about 6 million tons by 1985.) The shipment estimate was also smoothed to reduce the importance of timing business cycles in the DRI forecast.

Annual shipment levels for these two scenarios are presented in Exhibits 1 and 2. In Scenario 1, the industry recovers from the current recession by 1982 and grows at an average annual rate of 2 percent through 1990. In Scenario 2, the industry growth is slower--only about 1.3 percent from 1982 to 1990. Although the difference in the steel shipment levels of the two scenarios appears slight--116 million tons (Scenario 1) versus 108.3 million tons (Scenario 2) in 1990 --it is sufficient to distinguish between a fully utilized, reasonably profitable, expansionary steel industry, and a capital-constrained, marginally profitable, but only moderately expanding steel industry.[2] Throughout the remainder of the report, future operating and financial characteristics of the steel industry will be discussed concurrently for both scenarios. In cases where TBS has performed sensitivity analyses on underlying assumptions, these analyses will be discussed with respect to Scenario 1 only.

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[1] Forecast in August 1981; since that date an economic recession has reduced this estimate to about 87.0 million tons.

[2] These projections assume that steel industry production will not be constrained by available supply or production capacity. Later in the report, it is shown that for Scenarios 1 and 2 in certain years during the latter part of the 1980s, restrictions on available production capacity are likely to limit steel production to levels below those shown in Exhibits 1 and 2. These restrictions would result from the rapid expansion of the industry in Scenario 1 and the years of cyclically high demand in Scenario 2. By the early 1990s, restrictions on production capacity would be overcome.

FUTURE OPERATIONS AND MAINTENANCE EXPENSES

PTm(Steel) calculates O&M expenses by first determining levels of production for each production process that are consistent with the baseline steel shipments forecast. TBS has segmented the iron and steel industry into 28 production processes (Exhibit 3), which have been grouped into five stages of steel production: on-site raw materials preparation, ironmaking, raw steelmaking, casting and forming, and finishing.[3] When these production levels were combined with the resources utilized per unit of production in each process and the prices of those resources, the baseline O&M expenses shown in Table II-1 were obtained.[4] A more detailed breakdown of these O&M expenses can be found in Exhibit 4.

Table II-1

OPERATIONS AND MAINTENANCE EXPENSES
FOR IRON AND STEEL PRODUCTION

(millions of 1980 dollars)

	Scenario 1		Scenario 2	
	1985	1990	1985	1990
Basic Raw Materials	$12,088.8	$14,401.0	$11,519.5	$13,502.6
Direct Labor and Overhead	16,962.2	18,822.8	16,700.5	17,231.1
Other O&M Costs	12,673.5	14,620.9	11,946.8	13,844.4
Total	$41,724.5	$47,844.7	$40,166.8	$44,578.1

Source: PTm(Steel).

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[3] The 28 processes have also been grouped into two phases: the processes preceding and including ingot and continuous casting constitute Phase I, and the remaining processes make up Phase II. Processes ancillary to steel production, such as on-site generation of steam and electricity, have been grouped into a 29th process.

[4] A description of the resources utilized per unit of production in each process was obtained from ADL through the AISI.

O&M expenses, which form the largest component of steel industry costs, are dominated by basic raw materials costs and labor-related costs. The remaining O&M expenses include the costs of other raw materials (e.g., fluxes and alloying elements), energy costs, and the costs of miscellaneous supplies and utilities.

Basic raw materials, which include iron ore, metallurgical coal, and steel scrap, form a major component of O&M expenses--29.2 percent in 1981 and 30.1 percent in 1990 in Scenario 1. Scenario 2 would have a similar breakdown of components. To project coal prices, TBS has used the DRI OPTIMLONG data forecast of coal price increases. In the future, the rate of change in iron ore prices is expected to be close to the rate of change in coal prices. However, since productivity in ore mines is expected to rise 0.5 percent faster per year than productivity in coal mines, the inflation rate for the price of coal is set 0.5 percent above the price of iron ore. Steel scrap prices depend on many factors, but over the long term tend to be closely related to inflation. Therefore, TBS has used the GNP deflator to forecast scrap prices.

TBS has assumed that the other principal component of O&M expenses, direct labor and labor-related overhead charges, will escalate in proportion to the per capita GNP. The labor cost share of O&M expenses will decline slightly during the next decade (from 40.8 percent in 1981 to 39.3 percent in 1990 in Scenario 1) primarily because raw materials and energy prices are likely to increase at a somewhat faster rate.

STEEL INDUSTRY PROFITABILITY AND CAPITAL EXPENDITURES

The future capital expenditures program to be undertaken by the steel industry will be influenced both by historically low levels of profitability and by projections of future profitability. TBS has assumed that industry profitability in the years 1981 to 1990 will be based on the utilization of raw steelmaking capacity.

In the period 1970 to 1980 (except for the boom years 1973 and 1974), raw steel utilization averaged 82 percent, and the industry rate of return on equity equalled the average rate of inflation. In 1973 and 1974, utilization averaged 97 percent, and return on equity approximated the return for nonfinancial corporations. On the basis of this evidence, TBS assumed an industry return on equity equal to the rate of inflation when the utilization of raw steelmaking capacity was less than or equal to 85 percent. When utilization was 100 percent, TBS assumed an industry return on equity equal to the average rate of return for nonfinancial corporations. When it was greater than 85 percent, the rate of return was calculated by interpolating between the two points. Exhibit 5 details the return on equity for the 1970-1980 period.

Profitability affects the steel industry's future in at least three important ways. First, profits provide returns to its stockholders as well as much of the cash the industry uses to finance investments needed for the maintenance and expansion of its capital stock. Second, the current high profits provide assurance to potential purchasers of steel industry common stock that they will receive a return on their investment. Thus, high profits ensure that market prices for common stock will be high, allowing companies to issue additional common stock without dilution of present shareholders' interests. Third, poor profits diminish the industry's credit rating and therefore its ability to raise capital through the issuance of debt.

In the 1970s, low profitability, coupled with large capital expenditures for production facilities and pollution control equipment, virtually eliminated the steel industry's sources of equity capital and stretched its ability to issue additional debt. As a result, the credit quality of steel industry debt declined.

Additional issues of debt would tend to degrade such key measures of credit quality as the cash-flow-to-long-term-debt ratio, the interest coverage ratio, and, most important, the debt-to-capitalization ratio. Although the bulk of the industry is given a credit rating of A by Standard & Poor's and Moody's, if issues of debt further degrade the industry's credit quality, the industry's rating could be reduced to the lowest investment grade (Standard & Poor's BBB and Moody's Baa) or, worse yet, below investment grade. Under normal credit market conditions, a BBB/Baa-rated company is relatively assured of having access to debt capital on reasonable terms. However, during tight credit market conditions, a BBB/Baa-rated company may not be able to raise its capital requirements on reasonable terms. Consequently, the additional costs and potential financing difficulties associated with a BBB/Baa rating (or lower) are likely to lead steel industry managements to constrain their capital expenditures and debt financing to levels consistent with the preservation of an A bond quality rating.

The TBS analysis reflects the foregoing financial considerations in two important ways. First, it was assumed that common stock financing would not be undertaken by the steel industry unless it could demonstrate a long-term profit potential for several years. Second, the steel industry's debt-to-capitalization ratio was limited to approximately 35 percent in order to preserve its current credit rating. This limit on debt financing in turn implied limits on the capital expenditures that the industry would be likely to undertake. It was assumed that the industry would probably reduce the capital expenditures invested in its existing facilities to levels below those considered desirable by knowledgeable industry sources. Such reductions would make it more difficult for the industry to maintain its current level of improvement in productivity, quality, energy conservation, and cost reduction. Moreover, the industry would be less able to meet U.S. steel requirements during future periods of high demand and would thus lose a part of its share of the U.S. steel market.

The future capacity of the U.S. steel industry depends on capacity retirements, capacity additions, and the level of reinvestment in existing facilities. In the following sections, each of these activities will be examined in light of the financial constraints discussed above.

CAPACITY RETIREMENTS

The industry is likely to undertake production capacity retirements in response to several economic factors. First, the obsolescence of many facilities has reduced their competitiveness and potential for future productivity gains. Second, low profitability in the industry has sent a clear signal to the steel companies that a significant reduction in the number of facilities is in order. Finally, pollution control regulations have hastened retirements of some facilities so that capital expenditures for pollution control equipment can be avoided.

Estimates of facility retirements through the year 1984 were obtained from the Air Enforcement Division of EPA. Most of these facility retirements have been formalized as court orders and consent decrees stemming from EPA enforcement actions. These estimates of retirements were augmented with announced capacity shutdown figures from various articles and studies on the steel industry. Beyond 1984, a retirement rate of 5 percent per year of the capacity associated with Phase I facilities that are extensively underutilized and that are between 20 and 40 years old was assumed. This assumption translates into significant retirements of sinter strands, coke ovens, blast furnaces, open hearth furnaces, and ingot casting and primary breaking facilities. Exhibit 6 indicates past and projected facility retirements, by process, from 1976 to 1990 for Scenarios 1 and 2.

TBS assumed in its analysis that closing inefficient plants would result in a cost savings to the industry. On the basis of data provided in ADL's report to the AISI, TBS assumed a cost savings of $80 of annual savings per ton for the first 3 million tons of capacity closed. For closures beyond 3 million tons, a cost savings of $30 per ton was used. These cost savings were included in the baseline for Scenarios 1 and 2.

CAPACITY ADDITIONS

Low historical levels of profitability have reduced the number of attractive investments in production capacity available to the steel industry. As a result, expenditures for new capacity in the past have not been adequate to maintain the industry at the peak level of efficiency necessary to compete effectively with foreign producers.

Estimates of capital expenditures for new capacity during the 1976-1984 period were obtained by combining capacity addition announcements published in the steel industry press with construction cost data developed by the AISI.

From 1985 to 1990, the level of capital expenditures for new capacity reflects the limit on the steel industry's investment program for production equipment imposed by its weak financial condition and its desire to maintain current financial ratings. Most outlays will be directed toward a reduction of production bottlenecks. Since these additions facilitate the balanced flow of materials throughout the various stages of steel production, they offer particularly high returns on investment.

In Scenario 1, reducing production bottlenecks would require the addition of 6.70 million tons of blast furnace capacity between 1980 and 1990. Because modern blast furnaces have greatly improved coking rates, only small additions to coke oven capacity would be necessary. Reductions in production bottlenecks would also require 8.48 million tons of raw steelmaking capacity between 1980 and 1984 and an additional

7.60 million tons by 1990. These requirements reflect sizable shutdowns of open hearth steelmaking furnaces during the 1976-1990 period. Additions of electric arc furnaces (which are associated with or in competition with highly profitable mini-mills) would exceed additions of basic oxygen furnaces. Continuing a trend toward higher yields in the casting and forming stage, the steel industry would install approximately 56.59 million tons of continuous casting capacity between 1980 and 1990.

In Scenario 2, lower shipment requirements in the 1984-1990 period would require fewer capacity additions to eliminate bottlenecks than were required in the first scenario. Exhibit 7 summarizes the capacity additions by process and time period for Scenario 1 and Scenario 2.

The capacity additions in Scenario 1 would require $10,556.6 million[5] to be spent in the 1981-1990 period. Of this amount, $170.0 million would be allocated to new blast furnaces, $704.3 million to new steelmaking furnaces, and $4,958.1 million to new casting processes.

In Scenario 2, $8,040.5 million would be spent on new capacity in the 1981-1990 period. Unlike the case in Scenario 1, in which expenditures are directed toward alleviating steelmaking capacity constraints, in Scenario 2 a greater proportion of these expenditures would be allocated to new casting processes in order to improve profitability. Exhibit 8 details the allocation of baseline capital expenditures for capacity additions by process and time period, for Scenario 1 and Scenario 2.

Capital expenditures include all cash outlays necessary to bring new production capacity into service. New capacity additions normally require several years to construct, with cash outlays associated with the construction process occurring in each of the years. PTm(Steel) keeps track of funds spent in the past through a construction-work-in-progress (CWIP) account. In the 1981-1990 period, CWIP would average $3,680.6 million in Scenario 1 and $2,842.5 million in Scenario 2. Because CWIP is a sizable application of funds, it influences external financing requirements and interest expenses.

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[5] Unless otherwise indicated, cost and value estimates are reported in 1980 dollars.

REINVESTMENT IN EXISTING FACILITIES

Steel production facilities periodically require overhaul or replacement of worn-out equipment and modification to meet demands for new products, to improve productivity and product quality, and to adapt to new production technologies. The major components of these expenditures in the steel industry include the relining of ironmaking and steelmaking furnaces, the overhaul of ovens within a coke battery, the replacement of rolls and stools in the finishing processes, and the replacement of the various types of mobile equipment. Reinvestment in existing facilities can be deferred for brief periods, but a sustained reduction in these expenditures leads to a corresponding decline in production capacity.

The degree to which capacity is reduced depends on the reduction in capital investment relative to the replacement value of the industry's capital stock. Based on industry information recently updated by TBS, the replacement value of the capital stock of the U.S. steel industry is approximately $81.1 billion (in 1980 dollars). Of this, approximately 2.2 percent, or $1.8 billion, must be spent each year on existing equipment to maintain efficiency and competitiveness and to adjust for changes in technology and product mix. Reductions in the investment in capital stock from this level would cause the value of the capital stock to decrease by an equal amount. For example, a $1.0 billion reduction would result in a 1.2 percent decline in shipment capability, or about 1.2 million tons annually. If reduced capability were to coincide with a period of high demand for steel products, then the impacts on production, employment, and market share would be more pronounced.

In Scenario 1, the industry would need to reduce its capital expenditures on existing equipment by about $813.3 million per year through 1985 in order to maintain its current bond rating. This sustained reduction, therefore, would lead to a decline in production capability of about 6.9 million tons of finished steel products. At a utilization rate of 90 percent for raw steelmaking processes, only 98.8 million tons could actually be shipped. This is only 92 percent of the projected demand for domestic steel of 108 million tons. If the excess demand were supplied by imports, then market share in 1985 would decline 7.2 percentage points to 77.3 percent.

By 1987, continuing capacity constraints and the accompanying high profitability would allow the steel industry to issue large amounts of common stock. Issuing additional common stock would provide the funds needed to reduce the backlog of delayed expenditures on existing equipment, which would expand capacity so that the industry could regain its current market share of about 84.5 percent by 1990.

In Scenario 2, capital expenditures on existing equipment would need to be reduced by an average of $693.4 million per year below desired levels through 1985 in order to maintain the industry's bond rating. This reduction would result in a decline in production capacity of about 6.0 million tons per year, which would contribute to the industry's decline in market share from 84.5 percent to 82.9 percent.

After 1985, a combination of factors would allow the steel industry to begin to recover slowly from declines in market share. These factors include the tax reductions associated with the Economic Recovery Tax Act and the higher profitability stemming from higher utilization rates. In 1990, a year of cyclically high demand, market share would fall to 80.67 percent. However, by 1990, the industry would be able to rework and modernize much of its inefficient equipment. Although the steel industry would not be able to issue significant amounts of common stock by the early 1990s, its financial condition would improve markedly, and it would be left with adequate funds to regain and maintain its competitive position. Exhibit 9 details the baseline reinvestment in existing facilities, by year, for Scenario 1 and Scenario 2.

FUTURE COSTS FOR BASELINE POLLUTION CONTROL EQUIPMENT

In addition to costs related to iron and steel production, the baselines for Scenarios 1 and 2 include certain costs for water and air pollution control. Including these costs in the baselines influences the evaluation of the effects of proposed regulations in three important ways. First, if more equipment associated with a given regulation is in place, then future capital expenditures necessary to reach compliance with the regulation are reduced. Second, capital expenditures made in the past have increased depreciation charges, which are a source of funds for future expenditures. Third, equipment installed in the past must be supported by O&M expenses and debt and interest payments. The capital and operating costs of water and air pollution control equipment that are included in the baseline descriptions are summarized below.

Air Pollution Control Costs

The steel industry has developed a program for compliance with the Clean Air Act Amendments of 1970 and 1977 (herein referred to as the Air Act). The large capital expenditures associated with air pollution control equipment in place or committed to be installed to bring the industry into full compliance by 1984 are included in the baselines for Scenarios 1 and 2. This equipment is necessary to meet the air emission standards that cover the steel production processes as well as the on-site boilers used in generating electricity.[6]

Costing Methodology

The procedure for deriving total air pollution control costs involves the estimation of three basic parameters:

- Unit treatment costs
- The number of facilities in existence as of a particular date
- The percentage of facilities in compliance with the applicable State Implementation Plans (SIPs)

In addition, the methodology accommodates differences in SIPs, production processes, emission categories (stack, fugitive, or new sources), facility sizes, utilization rates, and implementation schedules.

Determination of unit treatment costs is complicated by the fact that neither federal law nor EPA regulation specifies which treatment facilities can satisfy the Air Act's requirements. Individual steel firms must make their own judgments based on SIP requirements (which vary by state), costs, and availability. Even in the area of New Source Performance Standards (NSPS), where a uniform federal regulation does exist, states may supersede EPA standards with more stringent emission limitations. Cost estimates from the 1979 report by

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[6] Air pollution control equipment associated with ancillary facilities or on-site boilers is described herein as miscellaneous pollution control equipment.

PEDCo entitled The Impact of New Source Review Policy on Capacity Expansion in the Integrated Iron and Steel Industry (EPA Contract Number 68-01-5135 PN 3417), as well as additional updated cost estimates from PEDCo, have been used by TBS as the basis for projecting air-related cost impacts.

PEDCo formulated control technologies to treat the following pollutants: particulate matter, sulfur and nitrous oxides, and hydrocarbons. The uncontrolled emission levels associated with each source were based on published emission factors, engineering judgments, and information gathered by EPA. The emission levels after the application of various control technologies were defined as specified percentages of the uncontrolled emissions. PEDCo related these emission rates to the emission limitations associated with each general technology requirement (i.e., RACT, BACT, and LAER). Input to this process was also obtained from EPA's Division of Stationary Source Enforcement (DSSE). The result of this analysis was a specification of the control technologies that would on average satisfy SIPs in the major steel-producing regions of the country.

Legal delays and permit interpretation have caused delays in the deadlines for the installation of these control technologies. Therefore, a schedule of compliance (Exhibit 10) with the Air Act's requirements for each steelmaking process was generated by TBS in conjunction with DSSE. This compliance schedule, along with the unit treatment costs discussed earlier, were combined with PTm(Steel) capacity forecasts to determine total air pollution control costs associated with the Air Act. These costs have been analyzed within the context of the previously described steel industry baseline conditions to determine their economic effects. Data pertaining to air pollution control costs for steel production processes are provided in Exhibits 11 through 15.

Capital Expenditures for Air Pollution Control Equipment

TBS estimated that under Scenario 1, $5,194.7 million in capital expenditures would be required for air pollution control equipment, with the funds to be allocated as shown in Table II-2.

Table II-2

CAPITAL EXPENDITURES FOR
AIR POLLUTION CONTROL EQUIPMENT

(millions of 1980 dollars)

	Scenario 1				Scenario 2			
	Prior to 1982	1982-1985	1986-1990	Total	Prior to 1982	1982-1985	1986-1990	Total
Stack Emissions	$3,527.1	$176.8	$ 0.0	$3,703.9	$3,527.1	$176.8	$ 0.0	$3,703.9
Fugitive Emissions	597.3	301.6	0.0	898.9	597.3	301.6	0.0	898.9
NSPS	260.5	153.2	178.2	591.9	260.5	153.2	57.1	470.8
Total	$4,384.9	$631.6	$178.2	$5,194.7	$4,384.9	$631.6	$57.1	$5,073.6

Source: PTm(Steel).

These capital expenditures are detailed for each production process by time period and type of emission in Exhibits 11 and 12, respectively. The majority of funds, about 60 percent, would be spent to control emissions from coke ovens and blast furnaces. Over 97 percent of all air pollution control costs would be associated with the Phase I raw materials preparation, ironmaking and steelmaking, and casting; few emissions and the corresponding control costs would result from the forming and finishing operations.

The industry is expected to have spent nearly 85 percent of the estimated $5,194.7 million in total air-related expenditures prior to 1982. A major portion of the remaining capital expenditures for the 1982-1985 period is expected to be devoted to coking compliance efforts (about 33 percent).

By 1985 nearly 97 percent of total capital expenditures for air pollution control would have been spent; these expenditures represent the capital outlays necessary to achieve 100 percent compliance across existing facilities. During the 1986-1990 period, an additional $178.1 million would be spent solely on NSPS sources.

The Air Act requires control of both stack- and fugitive-related emissions. In Scenario 1, nearly three quarters of all capital expenditures ($3,703.9 million) would be devoted to stack emission controls. Previous compliance efforts have resulted in 95 percent ($3,527.1 million) of the funds for stack emission controls being spent prior to 1982. Fugitive control costs ($898.9 million) represent approximately one sixth of total capital expenditures; two thirds of these expenditures were incurred prior to 1982. These expenditures generally occur after expenditures for stack controls, reflecting the more expeditious compliance schedule associated with stack controls. However, the distinction between stack and fugitive control costs is somewhat vague and therefore open to alternative interpretations.

The final category of capital outlay, NSPS expenditures, is associated with capacity additions after 1979. Any new source after that date must install the most stringent control technology (LAER). In Scenario 1, these expenditures would amount to $591.9 million. The NSPS expenditures, although they account for less than 12 percent of total capital outlay, represent the highest per-unit treatment cost. Exhibit 13 provides a yearly breakdown of expenditures by type of emission (stack, fugitive, and new sources).

In Scenario 2, $5,073.6 million in capital expenditures would be required for air pollution control equipment. As shown in Table II-2, the funds to be allocated for this equipment prior to 1986 are equal to the expenditures in Scenario 1. During the 1986-1990 period, the NSPS expenditures associated with capacity additions are less than those of Scenario 1, only $470.6 million. This figure reflects the smaller level of capacity additions in this period for Scenario 2 relative to Scenario 1.

Operations and Maintenance Expenses For Air Pollution Control Equipment

The O&M expenses required to operate air pollution control equipment through 1990 are summarized in Table II-3.

Table II-3

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT

(millions of 1980 dollars)

	Scenario 1		Scenario 2	
	1985	1990	1985	1990
Stack Emissions	$476.8	$478.1	$447.4	$472.8
Fugitive Emissions	180.1	183.5	169.0	176.2
NSPS	90.8	151.4	87.0	115.5
Total	$747.7	$813.0	$703.3	$764.4

Source: PTm(Steel).

Total O&M expenses are tabulated for each production process in Exhibit 14. This exhibit includes O&M expenses for all air pollution control equipment in operation during the 1980-1990 period. A yearly schedule of O&M charges (Exhibit 15) shows the 1980 cost level for Scenario 1 as $412.9 million. A 75 percent increase in these charges occurs by 1984, when the industry is to achieve full compliance.

By 1990, O&M expenses in Scenario 1 would total $813.0 million. Of this total, 59 percent would be associated with stack equipment, 22 percent with fugitive equipment, and 19 percent with NSPS equipment. In Scenario 2, this percentage breakdown would be similar, except that less emphasis--15 percent--would be placed on NSPS equipment.

The individual processes requiring the greatest level of capital expenditures--coke ovens and blast furnaces--would also necessitate a major portion of O&M charges, 36 percent and 12 percent, respectively. The steelmaking processes would require nearly 40 percent of total O&M expenses during 1990. The amount of air-related O&M charges in the steelmaking area would reflect the increased capacity of basic oxygen and electric arc furnaces. This additional steelmaking capacity, which requires the most stringent control technologies, is in part a result of replacing significant amounts of open hearth capacity.

Capital Expenditures and Operations and Maintenance Expenses for Miscellaneous Pollution Controls

The costs associated with the control of air pollution from ancillary boiler facilities were determined by PTm(Steel) using PEDCo unit cost data in conjunction with boiler capacity projections. Separate calculations for existing and NSPS facilities were made to reflect their different control costs. Costs were estimated on a per-boiler basis, with only the coal-fired units requiring emission control equipment.

TBS estimates that $431.2 million in cumulative capital expenditures and $155.8 million in O&M expenses would be required in Scenario 1 for air pollution control equipment associated with ancillary boilers in 1990. The funds would be allocated as detailed in Exhibit 16.

The pattern of capital expenditures reflects the compliance schedule associated with ancillary boiler facilities. In 1976, only 40 percent of all boiler units were in compliance with existing air standards. By the end of 1980, however, all boiler facilities should have rapidly achieved full compliance. Subsequent to 1980, a total of $72.0 million was spent on LAER control equipment to bring new boiler capacity into full compliance. After the addition of new boiler capacity, the increased utilization rates offset any need for further capacity expansion. The increased rates of utilization are reflected in the greater air-related O&M expenses during the latter portion of the study period.

Water Pollution Control Costs

The costs associated with water pollution control equipment in place as of June 1981 are included in the baseline descriptions of Scenarios 1 and 2. These costs have been incorporated into the baseline because they are not part of the incremental cost of the regulation. Details on the capital expenditures and O&M costs associated with in-place water pollution control equipment are provided in Chapter III. In addition, Chapter III discusses the anticipated costs associated with the final effluent guidelines. The implications of these costs relative to the baseline condition are reviewed in Chapters IV and V.

SENSITIVITY ANALYSIS: DRI INFLATION SERIES

As noted above, the future capital and O&M expenses in the baseline descriptions of Scenarios 1 and 2 are projected from the DRI OPTIMLONG forecasts of GNP for major components such as labor and raw materials. These forecasts assume the Administration's target inflation projections. Because of future economic uncertainty, TBS developed an alternative forecast of inflation to measure the sensitivity of the results of the analysis to slower economic recovery and more rapidly rising costs through the period. The inflation rates used by TBS are based on the DRI CYCLELONG series for Summer 1981.

SENSITIVITY ANALYSIS: AIR STRETCHOUT

As noted in preceding sections, the air costs discussed previously are based on a projected schedule of compliance with the Air Act by 1984. To measure the sensitivity of the results of the analysis to these projections, TBS developed an alternative schedule that measures the impacts of stretching out full compliance until 1985. The sensitivity analysis for air stretchout was performed using the baseline description of Scenario 1.

Exhibit 17 presents capital expenditures for air pollution controls for each of the compliance schedules. Note that total capital expenditures in the figure differ minimally after full compliance has been reached. This is a result of the interaction of capacity and compliance projections and the changing cost of constructing air pollution control equipment each year.

Late compliance with the Air Act regulations would imply lower capital expenditures during the short-term 1981-1984 period and decreased O&M expenditures.

III. COST IMPACT OF THE CLEAN WATER ACT

This chapter presents the cost to the steel industry of compliance with the final water effluent guidelines. The first section provides background information concerning TBS's cost calculation methodology. The next section presents a description of the cost impact of the guidelines in terms of capital expenditures for water pollution control equipment and O&M expenses. Finally, estimates of the capital cost of water pollution controls developed by TBS are compared with those prepared by EPA's technical contractor, NUS/Rice. The financial and economic implications of these water pollution control costs are discussed in Chapters IV and V.

The water pollution control costs described in this chapter are broken down into four categories corresponding to four separate categories of water pollution control requirements. The performance attainable through best practicable technologies (BPT) and best available technologies (BAT) is required for effluents discharged directly into navigable waters by 1984. Current indirect dischargers are required to meet pretreatment standards for existing sources (PSES) by 1984. Finally, newly constructed facilities discharging directly into navigable waters must meet new source performance standards (NSPS). A fifth category, pretreatment standards for new sources (PSNS), was not used since, for the purposes of this evaluation, all new sources were assumed to directly discharge into navigable waters.

COST IMPACT METHODOLOGY

TBS determined water pollution control costs by using PTm(Steel) in conjunction with model plant engineering cost estimates from NUS/Rice.[1] NUS/Rice's effluent control costs are used by PTm(Steel) in conjunction with projected capacity and production levels to calculate the total costs of compliance. The incidence of these costs is then determined by coverage schedules containing the percentage of steel facilities in each industry subcategory complying with each water regulation in each year. Capital expenditures vary with the number of incremental facilities achieving compliance in any year, and O&M charges depend on the total number of facilities in compliance and the utilization rates of facilities in each production process.

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[1] Development Document for Final Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category (to be published concurrently with this report).

In analyzing costs calculated in this fashion, TBS divided the aggregate cost impact of water pollution control into components defined by both effluent guideline and time period.

As described in Chapter II, the point of departure for the entire analysis is a baseline description for each scenario that includes water pollution control equipment installed as of July 1981. For purposes of analysis, additional installations of equipment to meet BPT, BAT, PSES, and NSPS requirements are considered incremental to the baseline description.

COST IMPACT OF THE GUIDELINES

The following sections describe the estimated costs for water pollution controls included in the baseline description and for each increment of additional control in Scenarios 1 and 2. Inherent in these costs are compliance schedule projections that assume compliance with BPT, BAT, and PSES by 1984 and with NSPS upon completion of all new facilities.

Capital Expenditures

By 1981, cumulative baseline capital expenditures for water pollution control had resulted in the installation of 89 percent of required BPT equipment, 27 percent of required BAT equipment, and 82 percent of required PSES equipment. The greatest part of the baseline impact was linked to capital expenditures for BPT compliance. These capital expenditures totaled $1,771.6 million in the years 1981 and before, or 93 percent of all baseline water-related capital expenditures for that period. Table III-1 presents the pattern of baseline capital expenditures for water pollution controls. The remaining capital expenditures for BPT compliance will occur in the years 1982 to 1984. These expenditures represent an additional $213.2 million in aggregate capital requirements, which raises the level of total capital expenditures associated with BPT effluent guidelines to $1,984.8 million. Approximately one half of this expenditure and one half of all capital expenditures for incremental BPT control are associated with compliance in the forming and finishing processes.

Table III-1

BASELINE
CAPITAL EXPENDITURES FOR
WATER POLLUTION CONTROL
EQUIPMENT

(millions of 1980 dollars)

BPT	$1,771.6
BAT	26.4
PSES	116.8
NSPS	0.0
Total	$1,914.8

Since most plants have not yet installed a level of treatment consistent with the BAT requirements, most of the capital expenditures for BAT control will be incremental to the baseline. Incremental capital expenditures required to bring the industry into full compliance with BAT regulations by 1984 are projected to be $70.1 million. This amount represents 73 percent of total BAT expenditures of $96.5 million.[2] Additional PSES requirements of $26.3 million will occur in 1982 to 1984. Table III-2 presents a schedule of capital expenditures for BPT, BAT, and PSES compliance through 1990.

After 1984, all capital expenditures for water pollution control are associated with NSPS requirements. Since the capacity additions in the years 1982 to 1990 differ under Scenarios 1 and 2, to reflect alternative future steel production levels, NSPS requirements will also differ. In Scenario 1, NSPS capital costs total $420.5 million. This figure represents about 4.0 percent of the costs associated with new capacity during the period. In Scenario 2, these costs equal $273.2 million, about 3.4 percent of the costs associated with installation of new capacity.

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[2] This figure does not include water pollution control capital expenditures for facilities in place but not required by this regulation.

Table III-2

INCREMENTAL
CAPITAL EXPENDITURES FOR WATER
POLLUTION CONTROL EQUIPMENT

1982-1990

(millions of dollars)

	Scenario 1	Scenario 2
BPT	$213.2	$213.2
BAT	70.1	70.1
PSES	26.3	26.3
NSPS	420.5	273.2
Total	$730.1	$582.8

A more detailed schedule of industry capital expenditures, by year, for each of these effluent guidelines during the 1982-1990 period for Scenarios 1 and 2 can be found in Exhibit 18. The schedule of total capital expenditures, including baseline and incremental BPT, BAT, PSES, and NSPS compliance efforts, by subcategory, for Scenarios 1 and 2 is shown in Exhibit 19.

Operations and Maintenance Expenses

O&M expenses for water pollution control equipment depend on annual capital expenditures for new and existing equipment, on retirements of production capacity, and on capacity utilization rates. Because TBS has developed two scenarios that vary by production level in each year, the O&M expenditures for these scenarios differ. This section describes the O&M costs separately for each scenario.

The O&M expenses projected for the short term for Scenario 1 are shown in Table III-3.

Table III-3

SHORT-TERM OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT

SCENARIO 1

1985

(millions of 1980 dollars)

	Baseline	Incremental	Total
BPT	$116.9	$ 7.4	$124.3
BAT	3.0	10.1	13.1
PSES	7.2	2.8	10.0
NSPS	0.0	13.5	13.5
Total	$127.1	$33.8	$160.9

Source: PTm(Steel) and Rice/EPA engineering cost estimates.

The baseline O&M figures include charges associated with equipment in service prior to 1976. In 1985, 94 percent of the O&M expenses for BPT and 72 percent of the O&M expenses for PSES are associated with pollution control equipment installed prior to 1981 and are included in the baseline condition of the industry. Seventy-seven percent of BAT expenses are associated with incremental equipment. As discussed earlier, 100 percent of NSPS expenditures are related to new capacity additions and are incremental to the baseline. Of the $160.9 million O&M charges for 1985, 74 percent, or $127.1 million, are associated with pollution control equipment required by the final regulation already in place by 1981.

Additional O&M expenditures in the long term are primarily the result of capital expenditures for NSPS controls for new capacity. In 1990, NSPS costs account for 63 percent of total incremental costs. However, NSPS costs constitute only 20 percent of total O&M expenses in 1990. Variations in the baseline O&M expenses between 1985 and 1990 are caused by differences in sectoral inflation rates and changes in capacity utilization rates. Table III-4 shows the long-term O&M expenses by control level.

Table III-4

LONG-TERM OPERATIONS AND MAINTENANCE EXPENSES
FOR WATER POLLUTION CONTROL EQUIPMENT

SCENARIO 1

1990

(millions of 1980 dollars)

	Baseline	Incremental	Total
BPT	$131.9	$10.2	$142.1
BAT	3.1	10.6	13.7
PSES	8.5	2.8	11.3
NSPS	0.0	40.7	40.7
Total	$143.5	$64.3	$207.8

Source: PTm(Steel) and Rice/EPA engineering cost estimates.

The O&M expenses projected for the short term for Scenario 2 are shown in Table III-5. As in Scenario 1, BPT and PSES costs account for almost all the baseline O&M expenses. Of the total O&M expenses for pollution control in 1985, 78 percent are associated with pollution control equipment in place in 1981.

Table III-6 provides the O&M expenses for Scenario 2 in 1990. Again, as in Scenario 1, additional O&M expenditures in the long term are largely a result of additional NSPS requirements. A more detailed tabulation of the O&M expenses by year for each of the effluent guidelines for Scenarios 1 and 2 is provided in Exhibit 20. These expenses are further delineated by subcategory for 1985 and 1990 in Exhibit 21.

Table III-5

SHORT-TERM OPERATIONS AND MAINTENANCE EXPENSES
FOR WATER POLLUTION CONTROL EQUIPMENT

SCENARIO 2

1985

(millions of 1980 dollars)

	Baseline	Incremental	Total
BPT	$120.6	$ 8.8	$129.4
BAT	2.8	9.6	12.4
PSES	7.6	2.5	10.1
NSPS	0.0	15.7	15.7
Total	$131.0	$36.6	$167.6

Source: PTm(Steel) and Rice/EPA engineering cost estimates.

Table III-6

LONG-TERM OPERATIONS AND MAINTENANCE
EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT

SCENARIO 2

1990

(millions of 1980 dollars)

	Baseline	Incremental	Total
BPT	$119.0	$ 7.9	$126.9
BAT	3.0	10.0	13.0
PSES	7.8	2.6	10.4
NSPS	0.0	27.8	27.8
Total	$129.8	$48.3	$178.1

Source: PTm(Steel) and Rice/EPA engineering cost estimates.

COMPARISON OF TBS AND NUS/RICE WATER COST ESTIMATES

Industrywide capital cost estimates for water pollution controls developed by EPA's technical contractor NUS/Rice were not used directly in either PTm(Steel) or TBS's economic analysis. Instead, TBS's cost estimates were based on model plant cost data prepared by NUS/Rice. Consequently, small differences resulted in the incremental capital costs of BPT, BAT, and PSES[3] requirements, as noted in Table III-7.

Table III-7

COMPARISON OF TBS AND NUS/RICE REQUIRED CAPITAL COSTS FOR WATER POLLUTION CONTROL

(millions of dollars)

	TBS (1980 $)	NUS/Rice (1978 $)
BPT	$213.2	$206.5
BAT	70.1	73.6
PSES	26.3	40.3
Total	$309.6	$320.4

The differences in the TBS and NUS/Rice capital costs are due to a variety of factors, including the following:

- NUS/Rice attempted to include all ironmaking and steelmaking facilities in its cost estimates. TBS included only those facilities associated with integrated mills. As an example, NUS/Rice included $2.8 million in additional BPT costs, $5.2 million in additional BAT costs, and $9.7 million in additional PSES costs (all in 1978 dollars) for the merchant coke industry. TBS analyzed separately the cost and impacts of the regulation on the merchant coke industry because the economic and financial structure of this industry is substantially different from that of the integrated iron and steel industry.

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[3] Industrywide NSPS costs were not estimated by NUS/Rice and were not considered in this comparison. NUS/Rice did estimate the model plant NSPS costs that were incorporated into the economic analysis.

- NUS/Rice costs are expressed in 1978 dollars and were based on the costs of labor, materials, and other resources as they were priced in 1978. The TBS costs were calculated in a two-step process. First, NUS/Rice 1978 costs of facilities were escalated to dollars of the 1982-1984 period, the period in which construction would be completed. Second, cost estimates were inflation-adjusted to 1980 dollars to allow cost comparisons on a constant-dollar basis.[4]

- In estimating industrywide capital costs, NUS/Rice made economy-of-scale adjustments to account for the deviations from the model plant size of each facility in its database. In order to conform with the steel industry economic model developed by the AISI, TBS made economy-of-scale adjustments to account for the deviations from the same model plant size of the average-sized facility in each industry subcategory.

- In general, TBS assumed that water pollution controls had not been installed in facilities that were to be retired in the next few years. In its plant-by-plant surveys, NUS/Rice found several instances in which pollution controls had been installed at plants that were expected to retire. In order to adjust for these differences, TBS assumed that to achieve full compliance, pollution controls would have to be installed at more than 100 percent of the facilities existing in 1984--that is, at all facilities existing in 1984 and at some facilities that would be retired.

However, because of variations in methodology, a complete resolution of the differences indicated in Table III-7 is not possible even after adjustments have been made for the factors discussed above. When corrected for the first two of the above factors, the NUS/Rice estimate becomes $320.9 million--3.6 percent higher than the TBS estimate of $309.6 million. The third and fourth factors have been incorporated into the TBS estimates as indicated. These estimates are reasonably close, and TBS considers the remaining differences to be insignificant in terms of economic impact.

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[4] For example, construction activity costing $1.00 in 1978 would escalate to $1.34 in 1983. This $1.34 in 1983, when adjusted for inflation, is worth only $1.06 in 1980 dollars.

IV. FINANCIAL EFFECTS

This chapter describes the revenue requirements and external financing requirements of the capital expenditures and O&M expenses associated with the baseline condition described in Chapter II and the additional water pollution controls described in Chapter III.

The steel industry's revenue requirements, which result from the effects of the capital expenditures and O&M expenses associated with steel production and pollution control, are determined by PTm(Steel). Revenue requirements are defined as those revenues that recover all costs, including a return on common equity. These costs include operating expenses, depreciation expenses, sales and property taxes, interest income and expenses, federal and state income taxes, and net income requirements. Computation of revenue requirements is complicated by the tax effects of the numerous forms of capital investment considered in PTm(Steel). These effects include investment tax credits and tax deferrals caused by timing differences in tax and book depreciation expenses.

The determination of revenues facilitates the calculation of the sources of funds from income, depreciation, deferred taxes, and external financing, and the calculation of the application of funds to capital expenditures. Changes in these flows of funds, along with the associated changes in the industrywide balance sheet, allow an examination of the important financial constraints facing the industry as it is affected by environmental regulations.

A schematic diagram of the financial module of PTm(Steel), which develops revenue requirements as well as industrywide annual financial statements, is provided in Exhibit 22.

The steel industry's need for external sources of capital stems primarily from its investments in new facilities, in the modernization and reworking of existing facilities, and in pollution control equipment. Steel industry managers determine the levels of these capital expenditures on the basis of their expectations of future profitability and future access to capital markets. In turn, the terms on which capital is available to a steel company depend chiefly on investor perceptions of the steel company's future profitability and the relative risks associated with other investment opportunities.

As discussed in Chapter II, the investment program that will be undertaken by the steel industry--even before consideration of additional water pollution control costs--is likely to be constrained by financing considerations.

Steel companies are unlikely to issue common stock as a source of external capital unless the industry can demonstrate a long-term profit potential for several years. In the near term, issuing new common stock is likely to be an unattractive alternative because it would result in a severe dilution of the book value of existing shareholders' stock. The market prices for steel companies' stock are currently at about 50 percent of their book values and will probably remain at this level for the next few years. The current low value that investors place on most steel company common stocks reflects both a history of low profitability and, perhaps more important, the expectation of low profitability in the future.

Issuing debt in the amounts necessary to meet the steel industry's potential external financing requirements is also likely to be unattractive to industry management. The amount of debt steel companies decide to employ depends to a great extent on their bond rating objectives. With current bond ratings for most major steel companies at a single A (several companies have recently been downgraded from an AA), most steel company managements are likely to be unwilling to take actions that would result in further bond rating declines.[1] Steel companies can attempt to prevent further bond rating declines by limiting the proportion of debt in their capital structures.

TBS's baseline projection reflects limits on the steel industry's investment program that are consistent with the preservation of current bond ratings. An unwillingness to take actions that would jeopardize bond ratings means, in effect, that the industry would have a fixed pool of capital available to allocate among new capacity, existing capacity, and pollution controls. Thus, additional outlays for water pollution controls would necessitate cutting back other investments rather than significantly altering baseline external financing requirements or financial conditions.

The next section presents the steel industry's baseline revenue and external financing requirements and its financial condition under Scenarios 1 and 2. The following section discusses the effects of future pollution control requirements on the industry's financial condition. The chapter concludes with analyses of the sensitivity of the financial results to several of the assumptions used to develop the baseline investment program, air-related compliance schedules, and the underlying economic projections.

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[1] See Chapter II for a discussion of the implications of low investment grade bond ratings.

BASELINE REVENUE AND EXTERNAL FINANCING REQUIREMENTS AND FINANCIAL CONDITION

The steel industry will experience financial constraints throughout most of the 1980s whether or not it meets the requirements of the final water pollution control regulation. In this section, the revenue and the external financing required by the industry without added water costs are described. This description forms the baseline from which the incremental financial effects can be compared.

Scenario 1

The baseline revenue requirements under the more profitable Scenario 1, which exclude additional water costs, would total $50,564.9 million in 1985 and $56,962.1 million in 1990. Projected baseline revenue requirements for the 1981-1990 period are shown in Table IV-1. Exhibit 23 provides a year-by-year breakdown of these requirements.

Table IV-1

REVENUE REQUIREMENTS FOR THE BASELINE CONDITION UNDER SCENARIO 1

(millions of 1980 dollars)

	1985	1990
Sales Tax	$ 2,007.4	$ 2,261.4
Operations and Maintenance Expenses	42,424.8	48,703.1
Capital-Related Charges	6,132.7	5,997.6
Total	$50,564.9	$56,962.1

Source: PTm(Steel).

In 1985, more than 83.9 percent of the required revenues for the baseline condition (which excludes consideration of costs for additional water pollution control equipment) would represent operating costs, about 12.1 percent would represent capital-related charges, and the remainder would be associated with sales taxes. By 1990, operating costs would account for 85.5 percent of revenue requirements, and capital-related charges for 10.5 percent.

Baseline external financing requirements in Scenario 1 would total $9,736.8 million over the 1980-1990 period. It is estimated that $7,332.2 million would be met by issuing new debt and that $2,404.6 million would be met by issuing common stock. The projected net external financing requirements would be significantly lower than the levels that have prevailed over the past decade because of the assumed constraint on capital outlays. In order to maintain the industry's current financial condition, the industry would need to reduce its capital expenditures on existing equipment by about $813.3 million per year through 1985--below levels considered necessary to maintain peak production efficiency.

By 1987, high levels of capacity utilization would have resulted in sustained profitability for a few years, thereby allowing the steel industry to issue large amounts of common stock. This would provide the funds needed to reduce the backlog of delayed expenditures on existing equipment and to expand capacity while maintaining current bond ratings.

Scenario 2

In Scenario 2, projected baseline revenue requirements, excluding consideration of costs for additional water pollution control equipment, would total $48,259.3 million in 1985 and $52,845.1 million in 1990. Table IV-2 shows these projected revenue requirements, and Exhibit 23 provides a year-by-year breakdown of these requirements.

The financial condition of the steel industry projected in the baseline under this scenario represents a continuation of recent financial performance levels throughout the decade. As a result, companies would be unlikely to issue common stock, and issues of debt would be constrained by the 35 percent debt-to-capitalization ratio through 1990. The industry would reduce capital expenditures by an average of $693.4 million per year on existing facilities through 1985. Although the industry would not be able to issue common stock prior to 1990, much of the inefficient equipment would be converted or closed down. By the early 1990s, the industry's financial condition would improve markedly.

Table IV-2

REVENUE REQUIREMENTS FOR THE BASELINE CONDITION
UNDER SCENARIO 2

(millions of 1980 dollars)

	1985	1990
Sales Tax	$ 1,915.8	$ 2,098.0
Operations and Maintenance Expenses	40,828.6	45,372.9
Capital-Related Charges	5,514.9	5,374.2
Total	$48,259.3	$52,845.1

Source: PTm(Steel).

FINANCIAL EFFECTS OF FUTURE WATER POLLUTION CONTROL EXPENDITURES

The financial effects of future expenditures for water pollution control equipment depend to a great extent on the magnitude of capital outlays required, the manner in which such outlays are financed, and the timing of these outlays. This section discusses the capital requirements, the revenue requirements, and the associated external financing needed to comply with the final pollution control regulation over the 1980-1990 period under Scenarios 1 and 2.

Three major assumptions influenced the results of this part of the analysis. First, the analysis assumed full pass-through of water pollution costs to the consumer. Under full pass-through, the industry would be able to raise prices to increase revenue (to recover fully all the operating and capital costs associated with pollution control equipment) and to maintain baseline profitability. The steel industry's prices are strongly driven by its costs, as evidenced by the fact that in each of the last 10 years (except the boom year 1974 and the period of extensive plant write-offs in 1977), the industry's return on sales has been between 2.1 and 4.8 percent. During this period, prices--and costs--have each increased 144 percent. TBS believes that in a cost-driven market, such as the market for steel products, small industrywide increases in operating costs, such as the costs of added water pollution control, are quickly translated into price increases.

Second, the analysis assumed that expenditures for pollution control equipment would be offset by a decline in baseline capital expenditures--more specifically, expenditures for existing equipment. This assumption is based on the likelihood that funds generated from other sources--specifically, from the industry's nonsteel operations and from the sale of coal reserves--would not be made available for pollution controls because industry managers could achieve a higher return on investments made outside the steel industry. As a result, capital expenditures for pollution control would not significantly change the net funds flowing out of the industry and would not affect its baseline financial condition. This assumption is conservative in its effect on the economic analysis because it focuses the entire impact of pollution controls on steel industry operations.

Finally, it was assumed that the closing of inefficient plants by the industry would result in a savings in operations and maintenance expenses. This assumption is reasonable and is consistent with the assumptions for cost savings proposed by Arthur D. Little in its 1981 report to the AISI, Environmental Policy for the 1980s: Impact on the American Steel Industry. As discussed above, it is likely that these cost savings would be passed through to the consumer in both scenarios. The final section of this chapter describes the sensitivity analysis that was performed on this assumption to determine the effects of passing through these cost savings to profits rather than to consumers.

The amount that reinvestment in existing equipment would need to be reduced to maintain current bond ratings in either scenario is a complex issue because bond ratings depend on many factors. A good approximation can be obtained, however, by reducing expenditures for existing equipment by an amount that would maintain the debt-to-capitalization ratio at its current level--approximately 35 percent. Other indicators of financial condition, such as the interest coverage ratio and the cash-flow-to-long-term debt ratio, would vary somewhat even if baseline debt-to-capitalization ratios were maintained. However, changes in the industry's overall credit quality resulting from a variation in other parameters would be minimal. External financing requirements would also depart somewhat from baseline levels if pollution control expenditures were substituted for expenditures for existing equipment because of differences in such factors as the timing of expenditures as well as book and tax depreciation effects.

Following a strategy of reducing expenditures for existing equipment to maintain the current financial condition means that the key effect of additional water pollution control requirements will be reduction in the capacity of older, less efficient facilities. The associated effects of such capacity reductions on steel industry prices, production, employment, and market share are discussed in Chapter V.

Scenario 1

During the 1980-1985 period,[2] capital expenditures for additional water pollution control would total $463.1 million. Afterwards, through 1990, additional expenditures of $267.0 million, or 37 percent of the 1980-1990 total, would be allocated for NSPS requirements on new equipment. As discussed above, these added expenditures would require further reductions in capital expenditures for existing production equipment beyond those described in the baseline condition during the years the industry is capital constrained. By 1987, higher profitability levels would allow the industry to issue common stock to provide the funds for reducing the backlog of needed capital expenditures.

The incremental revenue requirements in Scenario 1 that are related to the costs associated with BPT, BAT, PSES, and NSPS water effluent guidelines are shown in Table IV-3. The annual revenues required to fully recover the cost of water pollution control equipment would be $125.1 million by 1985 and $331.8 million by 1990. These increases would amount to 0.3 percent of the baseline revenues in 1985 and 0.6 percent in 1990.

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[2] Capital expenditures for additional water pollution control equipment would begin in 1982. However, the financial effects associated with commitments for equipment and other construction preparations would begin as early as 1980.

Table IV-3

INCREMENTAL REVENUE REQUIREMENTS
FOR WATER POLLUTION CONTROL EQUIPMENT

SCENARIO 1

(millions of 1980 dollars)

	1985	1990
BPT Additions	$ 53.0	$117.0
BAT Additions	25.8	40.2
PSES Additions	7.1	9.7
NSPS Additions	39.2	164.9
Total	$125.1	$331.8

Source: PTm(Steel).

Since it has been assumed that the steel industry could raise prices so that baseline profitability would be maintained, increased revenues would pay for most of the additional expenditures for water pollution control costs. External financing requirements over the 1980-1985 period would increase by only $31.8 million. A profitable industry in the last half of the decade would result in the issuing of common stock to facilitate both capital expenditures for pollution control and for capacity expansion. To meet these needs, net external financing would be expanded by $370.2 million in 1986-1990.

Scenario 2

During the 1980-1985 period, capital expenditures for added water pollution control would total $462.9 million. Additional expenditures of $119.9 million during the 1986-1990 period would be allocated for NSPS requirements on new equipment. As discussed above, under Scenario 2, slower recovery in the demand for finished steel products would lead to a continuation of low profitability levels throughout the decade. Although performance would improve by the second half of the decade, the industry would remain capital constrained, and the backlog of capital expenditures on existing equipment would still be present. By 1990 production capacity would have begun to increase, although cyclically high demand in that year, together with constraints on capacity, would keep the industry from meeting the demand. By the early 1990s, it is likely that the financial constraints would still be present, although the industry's production capability would be sufficient to satisfy the demand for domestically produced steel products.

The incremental revenue requirements related to the costs associated with BPT, BAT, PSES, and NSPS water effluent guidelines are shown in Table IV-4. The total revenue requirements associated with water pollution control additions would be $118.0 million in 1985 and $137.4 million in 1990.

Table IV-4

INCREMENTAL REVENUE REQUIREMENTS
FOR WATER POLLUTION CONTROL EQUIPMENT

SCENARIO 2

(millions of 1980 dollars)

	1985	1990
BPT Additions	$ 46.3	$ 37.8
BAT Additions	23.0	20.3
PSES Additions	7.1	2.6
NSPS Additions	41.6	76.7
Total	$118.0	$137.4

Source: PTm(Steel).

As in Scenario 1, the additional expenditures for water pollution control would be met in part through increasing external financing requirements. Over the 1980-1985 period, external financing would increase $21.2 million. External financing over the 1986-1990 period would be $44.7 million. Much of the increase would occur because expenditures on existing equipment would have been made possible by the improved financial condition of the industry.

SENSITIVITY ANALYSES

TBS conducted four sensitivity analyses to examine several of the assumptions in this study. In Chapter II, the sensitivities regarding underlying inflation rates and air pollution compliance schedules were discussed. In addition to performing these sensitivity analyses, TBS modified the assumptions concerning the costs of water pollution control requirements and the pass-through to the consumer of cost savings from closing inefficient plants. Each of these sensitivities is discussed in the remaining sections of this chapter. The results of these sensitivity analyses are detailed in Exhibits E-11 to E-14 of the Executive Summary.

Higher Inflation Rates

As discussed in Chapter II, TBS performed an analysis to test the sensitivity of the impacts of pollution control requirements on the steel industry to uncertain economic assumptions. This analysis assumed that costs would rise faster than they did in Scenario 1. Using an unadjusted DRI series, the underlying GNP price deflater averaged 8.8 percent per year, compared with an average adjusted 5.7 percent per year in Scenario 1.

Exhibits E-11 through E-14 indicate that while inflation assumptions have a slight effect on the baseline financial and economic condition of the steel industry, they have virtually no effect on the impact of added water pollution control costs. If the industry tried to maintain its current financial condition both with and without the added water costs, the relatively small changes in revenue and external financing requirements resulting from changes in the inflation rate assumptions would imply that the magnitude of productive capital expenditure cutbacks would be about the same as it would be in Scenario 1.

Double Water Costs

The water pollution control cost estimates used by TBS in Scenario 1 were based on the most accurate cost estimates currently available. In order to examine the sensitivity of the economic and financial impacts of water pollution control regulations for more costly alternatives, TBS performed an analysis using capital costs that were twice the magnitude of current estimates. This sensitivity assumed the same compliance schedule that was implicit in the results of the main scenario.

Doubling the capital costs of pollution control would result in roughly proportional impacts on revenue requirements. In order to maintain the same financial condition of the industry as in the baseline, short-term expenditures on existing equipment would be reduced in proportion to the increased capital costs. As in the long term, under Scenario 1, high profitability and continued capacity constraints would allow the industry to issue enough common stock to reduce the additional backlog of expenditures on existing capacity.

Air Stretchout

As discussed in Chapter II, TBS examined the sensitivity of the results of the impact analysis to the projected schedule of compliance with air pollution control regulations included in the baseline. The alternative schedule that TBS developed measures the impacts of postponing full compliance until 1985. Based on recent information that about $200 million (in 1978 dollars) of outstanding air pollution expenditures will probably be postponed, TBS assumed this amount in its sensitivity analysis.

Late compliance with the Air Act regulations would imply lower short-term capital and O&M expenditures. Exhibits E-11 through E-14 show that the financial benefits of relaxing compliance schedules are likely to be quite small.

Cost Savings Pass-Through to Profits

The financial effects of future water pollution control expenditures under Scenarios 1 and 2 were based on the assumption that cost savings resulting from the closing of inefficient plants are passed through to the consumer in the form of a reduced rate for price increases. To test the sensitivity of this assumption, TBS performed an analysis assuming zero cost savings pass-through to consumers in Scenario 1. This analysis, therefore, increased industry operating profits by the amount of the cost savings.

The results of this sensitivity analysis in terms of incremental revenue and external financing requirements are shown in Exhibits E-11 and E-13. In both the short term and the long term, cost savings passed through to profits would result in a significant increase in expenditures on existing equipment and a small increase in revenue requirements in the baseline. However, additional water pollution control expenditures would have roughly the same incremental financial impacts regardless of the pass-through assumption.

V. ECONOMIC IMPACTS OF ENVIRONMENTAL REGULATIONS

This chapter discusses the economic impacts that the final water effluent guideline will have on the steel industry's baseline condition. These effects include changes in the level of steel industry production, changes in the level of employment, and changes in the share of apparent consumption supplied by domestic producers. Minor effects on the price of steel and energy requirements are also expected. The economic impacts are derived from the financial analysis described in Chapter IV. These impacts stem from reduced expenditures for existing equipment as these reductions affect production capacity. Reductions in production capacity translate into economic impacts on employment and market share during periods of capacity constraints. As described in Chapter IV, this impact mechanism is reasonable, given the current financial condition of the industry, and conservative, in that it focuses the full impact of water pollution controls on the steel industry financial structure. Exhibit 24 indicates the factors considered in the economic module of PTm(Steel) and its relationships with the financial module.

As discussed in Chapter IV, when steel companies are faced with water pollution control requirements, they are likely to attempt to preserve their financial condition by cutting investment in existing productive assets. Therefore, the primary effects on the steel industry of the pending effluent guideline relate to the consequences of reduced investment.

In the following sections, the effects of pollution control regulations on price, production capacity, market share, employment, and energy requirements are discussed for Scenarios 1 and 2. In the final sections of this chapter, the effects of pollution control requirements on the merchant coke and the merchant pig iron industries are described. The results of the sensitivity analyses, described in detail in previous chapters, are presented in Exhibits E-11 to E-14 of the Executive Summary.

SCENARIO 1

As discussed in Chapter II, in Scenario 1, in the first half of the 1980s, the industry is likely to cut its modest baseline program for reinvestment in existing facilities (which already reflects significant reductions from levels considered desirable by knowledgeable industry sources) in response to water pollution control requirements to the extent necessary to maintain its credit quality at an A bond rating. By 1987, capacity constraints in the industry would improve profitability to the extent that new issues of common stock would be possible. By 1990, this influx of new capital would permit the industry to rework its old capacity and add new capacity. This would allow the industry to remove its capacity constraints, including the incremental constraints of added water costs. A detailed description of the economic impacts of pollution controls in Scenario 1 can be seen in Exhibits E-4 and E-6.

Price Effects

The impact of additional water pollution controls on steel prices was derived from the revenue impacts described in Chapter IV. As indicated in Exhibits E-4 and E-6, the price impact of added water costs in Scenario 1 would increase from $1.32 per ton in 1985 (0.3 percent of the baseline price) to $3.26 per ton in 1990 (0.6 percent of the baseline price). This increase between 1985 and 1990 would occur partly because of NSPS controls installed after 1985 and partly because of depreciation and other capital charges associated with an increased investment in existing equipment.

Production Capacity Effects

In Scenario 1, the potential declines of reinvestment in production capacity in the baseline would average $813.3 million below desirable levels from 1980 to 1985. Added water pollution control costs would increase this amount by approximately $84.2 million per year, which would lead to a decline in production capability of about 0.62 million tons of domestic finished steel products (0.6 percent of production capability).

By 1990, adequate capital would be available to the industry so that added pollution controls would not result in measurable impacts on production capacity. In fact, the industry would have the resources to add new capacity and to complete the investment in existing facilities postponed in previous years. At a 90 percent utilization rate, that annual production capacity would increase from about 98.15 million tons in 1985 to 116.00 million tons in 1990.

Market Share Effects

In the baseline, capacity constraints would cause the domestic steel industry's share of total apparent steel consumption to decline from the current nominal level of 84.50 percent to 77.28 percent by 1985. Additional water pollution controls would cause a further decline of 0.48 percentage points in market share.

As discussed in the previous section and in previous chapters of this report, the financial condition of the industry would improve substantially by 1990. At this time, the industry would have expanded capacity to meet demand for domestic finished steel products. The industry would be able to maintain a baseline market share of 84.5 percent even with the addition of water pollution controls.

Employment Effects

The gross employment effects in Scenario 1 associated with the operation of pollution control facilities in conjunction with production equipment are illustrated in Exhibit 25.

Capacity additions and expenditures on existing equipment that were delayed in the early part of the decade would contribute to higher employment in the long run. However, declines in capacity and the resulting declines in production would reduce employment in the short run.

It is anticipated that 10,370 steel industry jobs, or 2.3 percent of baseline employment, would be required by 1990 to operate all pollution control equipment. Compliance with air pollution control regulations, incorporated into the industry's baseline condition, would require 7,630 steel industry employees. Total water pollution control efforts would create 2,740 steel industry jobs. About 1,890 of these jobs would be linked to the operation of water pollution control equipment currently in place. Additional BPT compliance efforts after 1981 would account for about 260 new employees. BAT and PSES additions would provide about 60 and 30 jobs, respectively. The promulgation of New Source Performance Standards would provide 500 new employees, bringing the total level of employment resulting from all additional water pollution control requirements to 850 jobs.

In the short term, jobs created by the operation of pollution control equipment would be more than offset by the reduction in production labor that would result from additional water pollution control costs. In the baseline, the industry would incur a net loss in employment of 39,800 jobs (9.3 percent of baseline employment) in 1985 below levels required to attain a full 84.5 percent market share. The additional water costs would result in a further net reduction of 2,180 additional jobs in 1985 (0.5 percent of baseline employment). By 1990, capacity-related job losses would be recovered, and the additional water controls would account for an increase in employment of 850 jobs.

Energy Impacts

Nearly 9 percent of the net energy consumed in domestic industry is accounted for in the manufacture of iron and steel products. More than 40 percent of this amount is consumed in coke ovens and blast furnaces. In Scenario 1, pollution controls would consume only about 2.7 percent of the steel industry's net energy needs. Added water pollution controls would consume even less--0.1 percent--equivalent to about 1,100 barrels of oil a day. Exhibit 26 provides additional detail.

SCENARIO 2

In the first half of the 1980s, the economic condition of the steel industry in Scenario 2 would be somewhat better than it was in Scenario 1. A weak domestic demand for steel would limit the extent of market share impacts and would reduce the need for capital to finance capacity additions. In the mid-1980s, continued weak demand and low profitability would prevent the industry from achieving full economic recovery. However, by 1990 stronger demand and higher profits would have initiated a gradual recovery. By the early 1990s the steel industry would be stronger economically than it currently is.

Price Effects

Price increases in Scenario 2 resulting from added water costs would be similar in 1985 to those in Scenario 1. However, because of continued financial constraints, smaller NSPS requirements, and smaller investment in existing equipment, the additional price increase of $3.26 per ton indicated for Scenario 1 would not have occurred in Scenario 2 by 1990. A price impact of added water costs of $1.31 per ton in 1985 (0.2 percent of the baseline price) is expected to increase to only $1.44 per ton in 1990 (0.2 percent of the baseline price). As the industry's financial recovery continues into the early 1990s, the price impact should increase to about $3.30 per ton to pay for increased capital charges for existing equipment. Exhibits E-8 and E-10 provide more detail on the impacts on steel prices.

Production Capacity Effects

In order to maintain current bond ratings under Scenario 2, the steel industry would need to reduce capital expenditures on existing equipment by an average of $693.4 million per year below desired levels. This reduction would result in a decline in production capacity of about 5.97 million tons per year, or about 1 million tons less than in Scenario 1. The effect of additional water pollution controls would be a reduction in annual production capacity of an additional 0.61 million tons by 1985.

However, after 1985, lower demand for shipments of finished steel products would result in lower profitability than in the same period in Scenario 1. Although the industry would be able to close down or convert much of its inefficient equipment and its financial condition would begin to improve markedly, the industry would be unable to issue large amounts of common stock. As a result of these improvements, the extent of the baseline capacity decline would be reduced to about 2.97 million tons by 1990. Over the long term, added pollution controls would continue to result in declines in production capacity. By 1990, capacity declines of 0.41 million tons would result from additional water pollution controls. By the early 1990s, the industry would be able to clear the backlog of capital expenditures required to bring its equipment to full productive capacity. Exhibits E-8 and E-10 detail the short-run and long-run impacts of pollution control equipment on production capacity.

Market Share Effects

In Scenario 2, the industry's baseline market share in the short run would be 82.87 percent, a reduction of 1.63 percentage points from the current nominal 84.5 percent market share. As in Scenario 1, market share would decline slightly, by 0.55 percentage points, as a result of declines in production capacity resulting from additional pollution controls.

By 1990, market share would decline further to 80.67 percent in the baseline because of stronger cyclical demand for finished steel products and continued capacity constraints. However, as shown in Exhibit E-10, the effect of added pollution controls on market share would be reduced to 0.34 percentage points. In the early 1990s, faced with somewhat reduced demand but with higher capacity, the industry would be able to supply its current nominal 84.5 percent share of the domestic steel market.

Employment Effects

The gross employment effects associated with the operation of pollution control facilities in conjunction with production equipment in Scenario 2 are illustrated in Exhibit 25. The net effects, which include the impact of water costs on production capacity declines, are provided in Exhibits E-8 and E-10.

By 1990, 8,610 jobs, or 2.1 percent of baseline employment, would be necessary to operate pollution control equipment. Of this number, 6,100 jobs would be associated with air pollution controls, and 1,830 jobs would be associated with currently installed water pollution controls. The operation of additional pollution control equipment would require 680 jobs--260 to meet BPT requirements, 60 to meet BAT requirements, 20 to meet PSES requirements, and 340 to meet NSPS requirements.

Capacity declines related to constraints on capital would reduce employment in 1985 by 8,810 jobs (2.0 percent of baseline employment) below the levels required for the steel industry to attain a full 84.5 percent market share. Additional water pollution controls, while creating the 680 jobs mentioned above, would create production declines that would cost 3,150 jobs--a net loss of 2,470 jobs (0.6 percent of baseline employment). By 1990, the improved financial condition of the steel industry would diminish this job loss due to added water costs to a net reduction of 1,080 jobs (0.3 percent of baseline employment). In the early 1990s, employment declines resulting from water pollution controls would be eliminated as the industry begins to supply its full share of finished products to the domestic market.

Energy Impacts

Scenario 2 energy impacts are similar to those in Scenario 1. Exhibit 26 provides added detail.

EFFECTS OF WATER POLLUTION CONTROLS ON THE MERCHANT COKE INDUSTRY

The merchant coke and merchant pig iron industries use the same types of production facilities--coke ovens and blast furnaces--that are used in the steel industry. As a result, they are covered by the steel industry water regulation. However, the financial and economic structure of these industries is unlike that of the integrated steel industry. They are smaller in size, more diverse in terms of ownership patterns, and substantially different in terms of foreign trade protection. Because of these differences, economic analyses of these industries were performed separately, as described in this and the following sections.

The impacts on the merchant coke industry were obtained by examining the effects of the regulation on three parameters: annual costs as a percentage of total cash flow, debt-to-capitalization ratio, and capital costs as a percentage of replacement value. Annual costs as a percentage of total cash flow provide an indication of the impact of water pollution controls on the cash flow requirements for capital expenditures and other financial needs of the industry. This assumes that a substantial portion of the additional costs cannot be passed through to customers. The debt-to-capitalization ratio allows an examination of the impacts on the capital structure of the industry if the industry were able to issue additional debt to finance water pollution control expenditures. Capital costs as a percentage of replacement value provide an indication of the impact on a capital- and capacity-constrained industry. This concept is discussed in detail in Chapter II.

While these three parameters provide a basis for impact analysis under certain conditions, TBS does not believe that any of these conditions currently exist in the industry. As a result, current impacts are minimal, and these impact measures apply only to future periods when the conditions will be met. The most likely condition in the next decade is the development of capacity constraints that may occur as a result of increased demand, plant closures, or decreased import competition. Thus, TBS believes that capital cost as a percentage of replacement value is the best measure of impact.

Required capital and annual costs in 1978 dollars were obtained from EPA's technical contractor, NUS/Rice. These figures were broken out at the individual plant level for BPT, BAT, and PSES treatment requirements. TBS converted these required compliance levels to 1980 dollars by first expressing them in 1983 dollars (1983 is the average expected year of compliance). Capital costs and the various components of O&M costs were separately inflated to 1983 dollars to reflect differing historical and projected sectoral inflation rates. The costs in 1983 dollars were deflated to 1980 dollars using the estimated GNP deflator series.

The resulting compliance cost estimates are shown in Table V-1. As indicated, the industry's annual costs for all treatments total $5.0 million in 1980 dollars. Based on available data from firms within the merchant coke industry, and extrapolating to encompass the rest of the industry, TBS estimated that cash flow in 1980 was about $26 million. Given this cash flow, the required annual cost (including refunding of debt) of $5.0 million is about 20 percent of the cash flow. Based on a 1980 price of $135 per ton and 9.5 million tons of production, the added annual costs passed on to consumers will cause prices to increase by 0.4 percent.

Table V-1

MERCHANT COKE INDUSTRY
INCREMENTAL EFFLUENT REGULATION COSTS

(millions of 1980 dollars)

	Capital Cost	Annual Cost[1]
BPT	$ 3.0	$0.8
BAT	5.5	1.6
PSES	10.3	2.6
Total	$18.8	$5.0

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[1] Based on a capital recovery factor of 8.99 percent.

Source: TBS analysis.

The table also shows that the required capital costs for compliance with the water pollution control regulation (exclusive of in-place treatments) are about $18.8 million, in 1980 dollars. It is estimated that in 1980 the industry had a debt-to-capitalization ratio of 39.1 percent. To compute a future debt ratio that includes all future compliance costs, TBS assumed continued additions to retained earnings (in 1980 dollars), in order to estimate future net worth. Assuming the entire $18.8 million in required capital would be financed by debt, TBS then added this amount to current debt. The resulting new debt ratio increased from 39.1 percent to 39.6 percent, a minimal change.

Finally, capital costs were compared with the replacement value of capacity in the industry. Based on a current annual capacity of 9.5 million tons per year, the replacement value of the merchant coke industry at $220 per ton would be $2.1 billion. Total capital costs ($18.8 million) would be 0.9 percent of this replacement value. If these expenditures for pollution controls were diverted from capital expenditures that would otherwise have been made to maintain production equipment, then a loss of productive capability of about 0.9 percent could be expected. As a result, in future periods of capacity constraints, about 0.9 percent of production, or about 85,500 tons, would be lost to foreign producers because of compliance with added water pollution control requirements. The percentage impact on market share and employment is expected to be similar in magnitude.

When repeated at the individual firm level, this analysis yields ratios of compliance cost to replacement value ranging from 0.1 percent to 2.6 percent. The highest ratios occur for those plants having to install equipment required to comply with PSES. This is a result of the typical PSES plant's being smaller than average, with higher unit costs. Because of the relatively small impacts individual firms will experience, the water regulation is unlikely to force the closure of any merchant coke facilities.

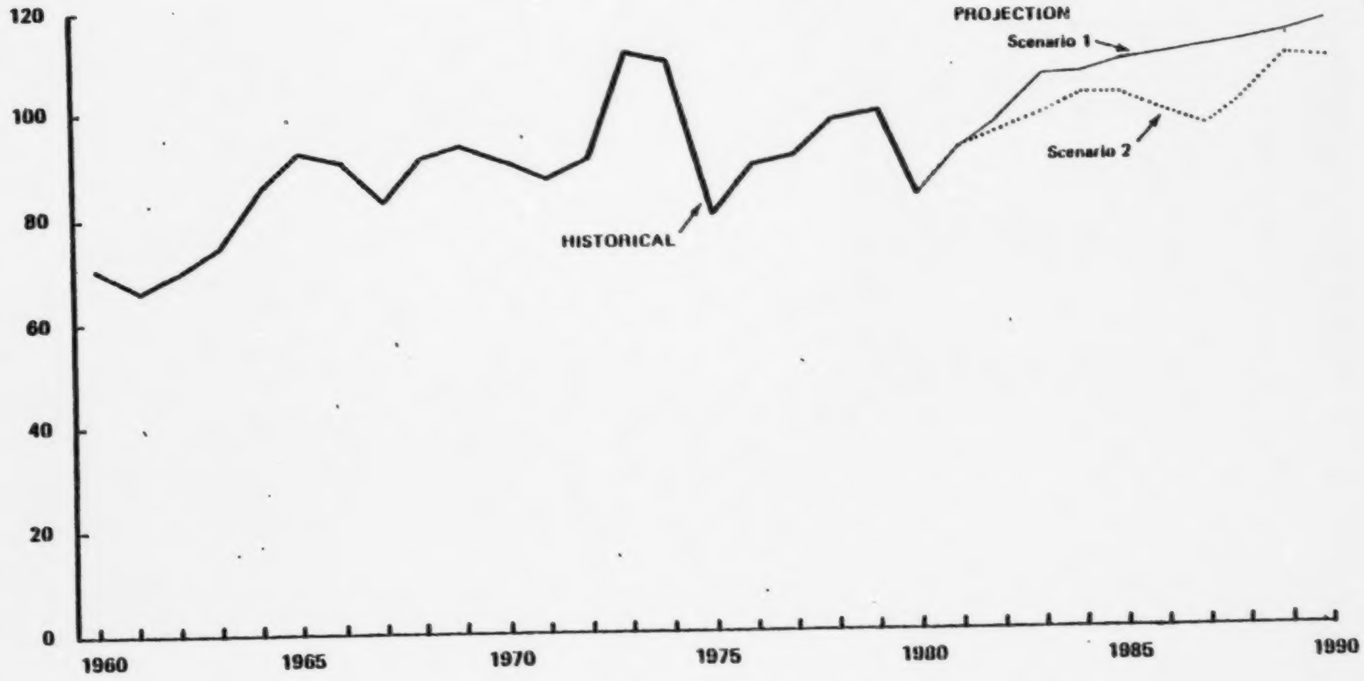
EFFECTS OF WATER POLLUTION CONTROLS ON THE MERCHANT PIG IRON INDUSTRY

The merchant pig iron industry consists of two firms that produce pig iron for casting. This industry is currently facing extensive competition from imports. A total of $1.91 million in added capital expenditures will be needed to meet the requirements of BPT effluent guidelines, and about $0.73 million will be needed to meet BAT guidelines. Annual costs for these requirements of about $0.5 million per year are likely to increase prices by 0.2 percent. These requirements represent 2.4 percent of the industry's replacement value (based on an industry capacity of 1.2 million tons per year and a replacement cost of $92 per ton). In periods of future capacity constraints, which at present appear unlikely, reductions in production of as much as 2.4 percent could be attributed to added water pollution controls. During such periods, employment would be impacted by a similar percentage. An analysis of the financial impacts of the water regulation is not presented because financial data were provided to EPA by the industry on a confidential basis. The results of the analysis indicate that any future scrapping of pig iron furnaces would most likely result from declining industry profitability and market share rather than from the costs of added water pollution controls.

Exhibit 1

DOMESTIC SHIPMENTS OF FINISHED STEEL PRODUCTS

(millions of tons)



Source: AISI *Annual Statistical Reports* and ADL and TBS projections.

Exhibit 2

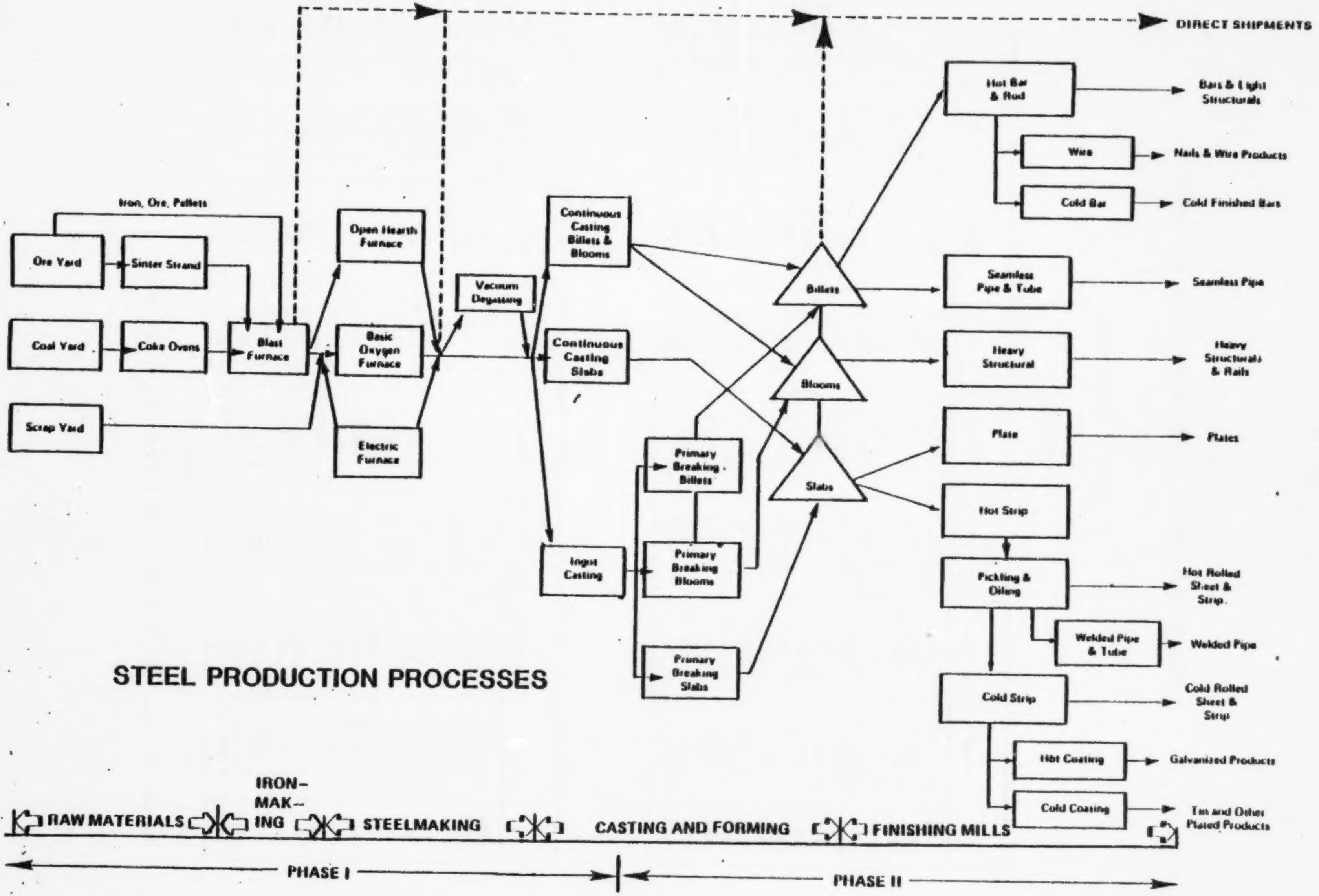
PROJECTED DOMESTIC SHIPMENTS OF FINISHED STEEL PRODUCTS

(millions of tons)

Year	Scenario 1	Scenario 2
1981	92.0	92.0
1982	98.0	96.5
1983	105.0	99.3
1984	106.0	103.9
1985	108.0	103.2
1986	109.0	99.8
1987	111.0	96.2
1988	112.0	101.5
1989	114.0	108.9
1990	116.0	108.3

Source: ADL and TBS projections.

Exhibit 3


DIRECT SHIPMENTS
Iron, Ore, Pellets
Ore Yard
Sinter Strand
Coal Yard
Coke Ovens
Scrap Yard
Blast Furnace
Open Hearth Furnace
Basic Oxygen Furnace
Electric Furnace
Vacuum Degassing
Continuous Casting Billets & Blooms
Continuous Casting Slabs
Ingot Casting
Primary Breaking Billets
Primary Breaking Blooms
Primary Breaking Slabs
Billets
Blooms
Slabs
Hot Bar & Rod
Wire
Cold Bar
Seamless Pipe & Tube
Heavy Structural
Plate
Hot Strip
Pickling & Oiling
Welded Pipe & Tube
Cold Strip
Hot Coating
Cold Coating
Bars & Light Structurals
Nails & Wire Products
Cold Finished Bars
Seamless Pipe
Heavy Structurals & Rails
Plates
Hot Rolled Sheet & Strip.
Welded Pipe
Cold Rolled Sheet & Strip
Galvanized Products
Tin and Other Plated Products
RAW MATERIALS
IRON-MAK-ING
STEELMAKING
CASTING AND FORMING
FINISHING MILLS
PHASE I
PHASE II

STEEL PRODUCTION PROCESSES

Source: TBS.

Exhibit 4

PRODUCTION OPERATIONS AND MAINTENANCE EXPENSES BY COST CATEGORY

1976-1990

(millions of 1980 dollars)

SCENARIO 1

Year	Labor	Overhead	Raw Materials	Power	Fuel	Water	Other	Total
1976	$5,717.9	$ 6,992.8	$ 9,795.7	$1,141.8	$ 108.8	$346.4	$7,357.7	$31,461.1
1977	5,995.0	7,326.9	9,453.8	1,279.9	168.2	347.8	7,447.7	32,019.3
1978	6,429.1	7,865.3	10,557.7	1,431.3	218.5	369.6	7,843.6	34,715.1
1979	6,510.1	7,987.2	11,171.6	1,488.5	295.0	373.0	7,916.6	35,741.9
1980	5,691.7	6,988.9	8,872.6	1,404.2	385.8	306.3	6,575.2	30,224.7
1981	5,982.7	7,365.5	9,574.2	1,630.5	497.3	334.5	7,356.0	32,740.7
1982	6,504.1	8,037.0	10,178.5	1,822.7	601.9	353.8	7,962.9	35,460.9
1983	7,096.2	8,706.8	11,108.8	1,958.2	653.2	382.5	8,621.3	38,527.0
1984	7,286.8	9,005.5	11,558.8	2,087.4	880.2	379.1	8,772.9	39,970.7
1985	7,574.2	9,388.0	12,088.8	2,182.3	1,061.0	384.1	9,046.1	41,724.5
1986	7,710.8	9,616.9	12,532.5	2,308.5	1,235.4	382.0	9,138.6	42,924.6
1987	7,879.7	9,939.0	13,034.4	2,480.7	1,485.2	382.0	9,393.9	44,594.9
1988	7,945.9	10,078.6	13,528.6	2,506.6	1,538.9	386.5	9,591.7	45,576.8
1989	8,097.1	10,356.4	13,969.0	2,544.7	1,601.4	392.0	9,712.8	46,673.5
1990	8,239.4	10,583.4	14,401.0	2,603.6	1,694.8	398.4	9,924.1	47,844.7

SCENARIO 2

Year	Labor	Overhead	Raw Materials	Power	Fuel	Water	Other	Total
1976	$5,717.9	$6,992.8	$ 9,795.7	$1,141.8	$ 108.8	$346.4	$7,357.7	$31,461.1
1977	5,995.0	7,326.9	9,453.8	1,279.9	168.2	347.8	7,447.7	32,019.3
1978	6,429.1	7,865.3	10,557.7	1,431.3	218.5	369.6	7,843.6	34,715.1
1979	6,510.1	7,987.2	11,171.6	1,488.5	295.0	373.0	7,916.6	35,741.9
1980	5,691.7	6,988.9	8,872.6	1,404.2	385.8	306.3	6,575.2	30,224.7
1981	6,023.3	7,485.1	9,565.3	1,624.9	494.9	333.3	7,294.9	32,821.7
1982	6,463.8	8,078.6	10,013.5	1,788.0	592.3	347.1	7,768.7	35,052.0
1983	6,797.2	8,451.4	10,497.5	1,846.0	625.8	360.5	8,082.6	36,661.0
1984	7,263.9	9,168.5	11,297.7	2,030.2	854.8	368.8	8,438.4	39,422.4
1985	7,371.3	9,329.2	11,519.5	2,070.8	1,012.4	364.6	8,499.0	40,166.8
1986	7,176.6	9,085.4	11,457.5	2,105.9	1,143.1	348.6	8,292.1	39,609.3
1987	6,901.0	8,804.5	11,273.5	2,140.8	1,277.8	329.8	8,064.3	38,791.7
1988	7,218.5	9,168.8	12,260.3	2,271.6	1,394.7	350.3	8,692.5	41,356.6
1989	7,677.7	9,712.9	13,384.2	2,443.2	1,544.9	376.2	9,389.2	44,528.4
1990	7,608.3	9,622.8	13,502.6	2,447.5	1,604.6	374.3	9,418.0	44,578.1

Note: Costs may not add to totals due to rounding.

Source: PTm(Steel) and Arthur D. Little engineering cost estimates.

Exhibit 5

RETURN ON EQUITY

1970-1980

(percent)

Year	Return on Equity
1970	4.1%
1971	4.3
1972	5.8
1973	9.3
1974	17.1
1975	9.8
1976	7.8
1977	0.1
1978	7.3
1979	6.7
1980	9.0
Averages	
1970-1980	7.4
1973-1974	13.2

Source: AISI *Annual Statistical Reports.*

Exhibit 6

CAPACITY RETIREMENTS

1976-1990

(millions of tons)

Process	1976 Capacity	Retirements											
		1976-1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Ore Yard	171.84	-	-	-	-	-	-	-	-	-	-	-	-
Coal Yard	88.22	-	-	-	-	-	-	-	-	-	-	-	-
Scrap Yard	73.61	-	-	-	-	-	-	-	-	-	-	-	-
Sintering	46.19	9.59	-	-	-	-	3.16	4.30	4.30	4.10	-	-	25.45
Coke Oven	60.17	2.45	2.37	4.48	6.60	-	2.24	-	2.85	-	-	-	20.99
Direct Reduction	-	-	-	-	-	-	-	-	-	-	-	-	-
Blast Furnace	106.51	11.93	0.94	5.69	-	0.86	1.41	6.45	6.45	6.45	-	-	40.18
Open Hearth	27.96	12.67	-	3.38	-	12.52	-	-	-	-	-	-	28.57
Basic Oxygen Furnace	86.57	-	3.26	-	-	-	2.95	-	-	-	-	-	6.21
Electric Furnace	24.33	-	0.01	-	-	-	-	2.90	2.90	2.60	2.60	-	11.01
Ingot Casting	121.93	-	-	-	-	-	-	8.40	8.50	-	3.10	5.90	25.90
Continuous Casting--Billets	5.75	5.21	0.03	-	-	-	-	-	-	-	-	-	5.24
Continuous Casting--Slabs	11.25	-	-	-	-	-	-	-	-	-	-	-	-
Primary Breakdown--Blooms	27.02	7.25	-	3.52	-	-	11.07	-	-	-	-	-	21.84
Primary Breakdown--Billets	25.98	4.99	-	9.47	-	-	-	-	-	8.73	-	-	23.19
Primary Breakdown--Slabs	74.92	2.57	-	1.27	-	-	4.16	-	-	-	-	-	8.00
Heavy Structurals	14.97	3.80	-	-	-	-	14.70	-	-	-	-	-	18.50
Bar Mill	26.76	0.87	0.01	-	-	-	4.04	-	-	-	-	-	4.92
Wire Mill	3.87	-	-	-	-	-	-	-	-	-	-	-	-
Cold Finished Bars	1.41	-	-	-	-	-	-	-	-	-	-	-	-
Seamless Pipe	3.69	-	-	-	-	-	-	-	-	-	-	-	-
Hot Strip Mill	73.15	3.83	-	-	-	-	2.87	-	-	-	-	-	6.70
Pickling	59.29	1.30	-	-	-	-	-	-	-	-	-	-	1.30
Welded Pipe	5.07	-	-	-	-	-	-	-	-	-	-	-	-
Cold Reduction	48.08	2.08	-	-	-	-	7.86	-	-	-	-	-	9.94
Galvanizing	8.01	-	-	-	-	-	-	-	-	-	-	-	-
Tin Plating	9.61	-	-	-	-	-	-	-	-	-	-	-	-
Plate Mill	13.25	7.44	-	-	-	-	-	-	-	-	-	-	7.44
Ancillary Facilities	-	-	-	-	-	-	-	-	-	-	-	-	-
Vacuum Degassing	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: TBS projections.

Exhibit 7

CAPACITY ADDITIONS

1976-1990

(millions of tons)

SCENARIO 1

Page 1 of 2

Process	1976 Capacity	Additions											
		1976-1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Ore Yard	171.84	9.59	-	-	-	-	-	-	-	-	-	-	9.59
Coal Yard	88.22	-	-	-	-	-	-	-	-	-	-	-	-
Scrap Yard	73.61	-	1.00	1.00	1.00	6.00	-	2.00	3.00	-	-	-	14.00
Sintering	46.19	-	-	-	-	-	-	-	-	-	-	-	-
Coke Oven	60.17	6.63	0.50	1.60	2.70	-	-	-	-	-	-	-	11.43
Direct Reduction	-	-	-	-	-	-	-	-	-	-	-	-	-
Blast Furnace	106.51	14.04	-	-	-	-	-	-	-	-	2.00	-	16.04
Open Hearth	27.96	-	-	-	-	-	-	-	-	-	-	-	-
Basic Oxygen Furnace	86.57	3.69	0.60	-	-	-	-	-	-	-	-	-	4.29
Electric Furnace	24.33	17.78	2.50	3.10	0.08	-	-	3.00	4.60	-	-	-	31.06
Ingot Casting	121.93	-	-	-	-	-	-	-	-	-	-	-	-
Continuous Casting--Billets	5.75	2.15	0.86	-	2.87	-	1.00	3.60	2.90	4.50	6.50	2.50	26.88
Continuous Casting--Slabs	11.25	6.52	1.00	2.23	0.38	6.81	-	-	2.30	-	9.55	5.52	34.31
Primary Breakdown--Blooms	27.02	0.70	-	-	-	-	-	-	-	-	-	-	0.70
Primary Breakdown--Billets	25.98	-	-	-	-	-	-	-	-	-	-	-	-
Primary Breakdown--Slabs	74.92	-	-	-	-	-	-	-	-	-	-	-	-
Heavy Structurals	14.97	-	0.40	-	0.70	0.70	-	-	-	-	-	-	1.80
Bar Mill	26.76	1.34	-	0.48	0.40	-	-	-	-	-	-	-	2.22
Wire Mill	3.87	0.08	-	-	-	-	-	-	-	-	-	-	0.08
Cold Finished Bars	1.41	-	0.50	0.90	-	-	-	-	-	-	-	-	1.40
Seamless Pipe	3.69	0.88	0.60	0.60	0.64	0.55	-	-	-	-	-	-	3.27
Hot Strip Mill	73.15	-	-	0.50	-	0.50	-	-	-	-	-	-	1.00
Pickling	59.29	-	-	-	-	-	-	-	-	-	-	-	-
Welded Pipe	5.07	0.87	-	0.04	0.15	-	-	-	-	-	-	-	1.06
Cold Reduction	48.08	0.12	0.35	1.00	-	-	-	-	-	-	-	-	1.47
Galvanizing	8.01	-	0.30	-	-	-	-	-	-	-	-	-	0.30
Tin Plating	9.61	-	-	-	-	-	-	-	-	-	-	-	-
Plate Mill	13.25	0.90	-	-	-	-	-	-	-	-	-	-	0.90
Ancillary Facilities	-	-	-	-	-	-	-	-	-	-	-	-	-
Vacuum Degassing	-	-	-	-	-	-	-	-	-	-	-	-	-

(continued)

Exhibit 7 (continued)

SCENARIO 2

Page 2 of 2

Process	1976 Capacity	Additions											
		1976-1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Ore Yard	171.84	9.59	-	-	-	-	-	-	-	-	-	-	9.59
Coal Yard	88.22	-	-	-	-	-	-	-	-	-	-	-	-
Scrap Yard	73.61	-	1.00	1.00	1.00	-	1.00	1.00	1.00	1.00	1.00	-	8.00
Sintering	46.19	-	-	-	-	-	-	-	-	-	-	-	-
Coke Oven	60.17	6.63	0.50	1.60	2.70	-	-	-	-	-	-	-	11.43
Direct Reduction	-	-	-	-	-	-	-	-	-	-	-	-	-
Blast Furnace	106.51	14.04	-	-	-	-	-	-	-	-	2.00	-	16.04
Open Hearth	27.96	-	-	-	-	-	-	-	-	-	-	-	-
Basic Oxygen Furnace	86.57	3.69	0.60	-	-	-	-	-	-	-	-	-	4.29
Electric Furnace	24.33	17.78	2.50	3.10	0.08	-	-	-	-	-	-	-	23.46
Ingot Casting	121.93	-	-	-	-	-	-	-	-	-	-	-	-
Continuous Casting--Billets	5.75	2.15	0.86	-	0.67	2.20	1.00	-	2.90	4.50	6.50	2.50	23.28
Continuous Casting--Slabs	11.25	6.52	1.00	2.23	0.38	6.81	-	-	-	-	-	-	16.94
Primary Breakdown--Blooms	27.02	0.70	-	-	-	-	-	-	-	-	-	-	0.70
Primary Breakdown--Billets	25.98	-	-	-	-	-	-	-	-	-	-	-	-
Primary Breakdown--Slabs	74.92	-	-	-	-	-	-	-	-	-	-	-	-
Heavy Structurals	14.97	-	0.40	-	0.70	0.70	-	-	-	-	-	-	1.80
Bar Mill	26.76	1.34	-	0.48	0.40	-	-	-	-	-	-	-	2.22
Wire Mill	3.87	0.08	-	-	-	-	-	-	-	-	-	-	0.08
Cold Finished Bars	1.41	-	0.50	0.90	-	-	-	-	-	-	-	-	1.40
Seamless Pipe	3.69	0.88	0.60	0.60	0.64	0.55	-	-	-	-	-	-	3.27
Hot Strip Mill	73.15	-	-	0.50	-	0.50	-	-	-	-	-	-	1.00
Pickling	59.29	-	-	-	-	-	-	-	-	-	-	-	-
Welded Pipe	5.07	0.87	-	0.04	0.15	-	-	-	-	-	-	-	1.06
Cold Reduction	48.08	0.12	0.35	1.00	-	-	-	-	-	-	-	-	1.47
Galvanizing	8.01	-	0.30	-	-	-	-	-	-	-	-	-	0.30
Tin Plating	9.61	-	-	-	-	-	-	-	-	-	-	-	-
Plate Mill	13.25	0.90	-	-	-	-	-	-	-	-	-	-	0.90
Ancillary Facilities	-	-	-	-	-	-	-	-	-	-	-	-	-
Vacuum Degassing	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: TBS projections.

Exhibit 8

CAPITAL EXPENDITURES FOR CAPACITY ADDITIONS

1976-1990

(millions of 1980 dollars)

SCENARIO I

Page 1 of 2

Process	1976-1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Ore Yard	$ 123.3	-	-	-	-	-	-	-	-	-	-	$ 123.3
Coal Yard	-	-	-	-	-	-	-	-	-	-	-	-
Scrap Yard	-	$ 7.7	$ 7.5	$ 7.4	$ 43.9	-	$ 16.8	$ 25.0	-	-	-	108.3
Sintering	-	-	-	-	-	-	-	-	-	-	-	-
Coke Oven	1,321.4	94.8	296.3	491.1	-	-	-	-	-	-	-	2,203.6
Direct Reduction	-	-	-	-	-	-	-	-	-	-	-	-
Blast Furnace	1,172.8	-	-	-	-	-	-	-	-	$170.0	-	1,342.8
Open Hearth	-	-	-	-	-	-	-	-	-	-	-	-
Basic Oxygen Furnace	169.4	25.8	-	-	-	-	-	-	-	-	-	195.2
Electric Furnace	936.0	122.5	148.4	3.8	-	-	160.3	243.5	-	-	-	1,614.5
Ingot Casting	-	-	-	-	-	-	-	-	-	-	-	-
Continuous Casting--Billets	198.0	75.8	-	242.8	-	$97.1	346.1	276.2	$426.5	613.8	$234.4	2,510.7
Continuous Casting--Slabs	640.4	92.6	201.7	33.3	597.7	-	-	230.0	-	947.0	543.1	3,285.8
Primary Breakdown--Blooms	79.8	-	-	-	-	-	-	-	-	-	-	79.8
Primary Breakdown--Billets	-	-	-	-	-	-	-	-	-	-	-	-
Primary Breakdown--Slabs	-	-	-	-	-	-	-	-	-	-	-	-
Heavy Structurals	-	211.7	-	355.3	351.1	-	-	-	-	-	-	918.1
Bar Mill	281.3	-	95.6	78.3	-	-	-	-	-	-	-	455.2
Wire Mill	52.3	-	-	-	-	-	-	-	-	-	-	52.3
Cold Finished Bars	-	139.1	244.5	-	-	-	-	-	-	-	-	383.6
Seamless Pipe	618.6	406.8	397.3	416.2	353.4	-	-	-	-	-	-	2,192.3
Hot Strip Mill	-	-	60.8	-	59.0	-	-	-	-	-	-	119.8
Pickling	-	-	-	-	-	-	-	-	-	-	-	-
Welded Pipe	293.4	-	12.4	45.5	-	-	-	-	-	-	-	351.3
Cold Reduction	37.0	102.6	286.4	-	-	-	-	-	-	-	-	426.0
Galvanizing	-	117.7	-	-	-	-	-	-	-	-	-	117.7
Tin Plating	-	-	-	-	-	-	-	-	-	-	-	-
Plate Mill	197.4	-	-	-	-	-	-	-	-	-	-	197.4
Ancillary Facilities	-	-	-	-	-	-	-	-	-	-	-	-
Vacuum Degassing	-	-	-	-	-	-	-	-	-	-	-	-
Total	$6,121.1	$1,397.1	$1,750.9	$2,042.7	$1,405.1	$97.1	$523.2	$774.7	$426.5	$1,730.8	$777.5	$16,677.7

(continued)

Exhibit 8 (continued)

SCENARIO 2

Page 2 of 2

Process	1976–1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Ore Yard	$ 123.3	-	-	-	-	-	-	-	-	-	-	$ 123.3
Coal Yard	-	-	-	-	-	-	-	-	-	-	-	-
Scrap Yard	-	$ 7.7	$ 7.5	$ 7.4	-	$ 8.5	$8.4	$ 8.3	$ 8.3	$ 8.3	-	64.4
Sintering	-	-	-	-	-	-	-	-	-	-	-	-
Coke Oven	1,321.4	94.8	296.3	491.1	-	-	-	-	-	-	-	2,203.6
Direct Reduction	-	-	-	-	-	-	-	-	-	-	-	-
Blast Furnace	1,172.8	-	-	-	-	-	-	-	-	170.0	-	1,342.8
Open Hearth	-	-	-	-	-	-	-	-	-	-	-	-
Basic Oxygen Furnace	169.4	25.8	-	-	-	-	-	-	-	-	-	195.2
Electric Furnace	936.0	122.5	148.4	3.8	-	-	-	-	-	-	-	1,210.7
Ingot Casting	-	-	-	-	-	-	-	-	-	-	-	-
Continuous Casting--Billets	198.0	75.8	-	56.7	$ 183.9	97.1	-	276.2	426.5	613.8	$234.4	2,162.4
Continuous Casting--Slabs	640.4	92.6	201.7	33.3	597.7	-	-	-	-	-	-	1,565.7
Primary Breakdown--Blooms	79.8	-	-	-	-	-	-	-	-	-	-	79.8
Primary Breakdown--Billets	-	-	-	-	-	-	-	-	-	-	-	-
Primary Breakdown--Slabs	-	-	-	-	-	-	-	-	-	-	-	-
Heavy Structurals	-	211.7	-	355.3	351.1	-	-	-	-	-	-	918.1
Bar Mill	281.3	-	95.6	78.3	-	-	-	-	-	-	-	455.2
Wire Mill	52.3	-	-	-	-	-	-	-	-	-	-	52.3
Cold Finished Bars	-	139.1	244.5	-	-	-	-	-	-	-	-	383.6
Seamless Pipe	618.6	406.8	397.3	416.2	353.4	-	-	-	-	-	-	2,192.3
Hot Strip Mill	-	-	60.8	-	59.0	-	-	-	-	-	-	119.8
Pickling	-	-	-	-	-	-	-	-	-	-	-	-
Welded Pipe	293.4	-	12.4	45.5	-	-	-	-	-	-	-	351.3
Cold Reduction	37.0	102.6	286.4	-	-	-	-	-	-	-	-	426.0
Galvanizing	-	117.7	-	-	-	-	-	-	-	-	-	117.7
Tin Plating	-	-	-	-	-	-	-	-	-	-	-	-
Plate Mill	197.4	-	-	-	-	-	-	-	-	-	-	197.4
Ancillary Facilities	-	-	-	-	-	-	-	-	-	-	-	-
Vacuum Degassing	-	-	-	-	-	-	-	-	-	-	-	-
Total	$6,121.1	$1,397.1	$1,750.9	$1,487.6	$1,545.1	$105.6	$8.4	$284.5	$434.8	$792.1	$234.4	$14,161.6

Source: TBS projections.

Exhibit 9

BASELINE REINVESTMENT IN EXISTING FACILITIES

(millions of 1980 dollars)

Year	Scenario 1	Scenario 2
1982	$ 449.0	$ 499.7
1983	1,470.7	1,553.7
1984	1,579.3	2,056.2
1985	1,949.8	1,974.0
1986	1,472.8	1,980.3
1987	2,674.1	2,029.4
1988	2,632.6	2,156.5
1989	2,619.4	2,188.8
1990	2,636.0	1,831.0

Source: TBS projections.

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Exhibit 10

AIR POLLUTION CONTROL COMPLIANCE SCHEDULE

1976–1990

(percent)

Process	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1. Ore Yard															
Stack	0%	35%	55%	80%	95%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Fugitive	0	35	55	80	95	100	100	100	100	100	100	100	100	100	100
2. Coal Yard															
Stack	0	30	50	75	90	95	100	100	100	100	100	100	100	100	100
Fugitive	0	30	50	75	90	95	100	100	100	100	100	100	100	100	100
3. Scrap Yard															
Stack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Sintering															
Stack	20	27	40	60	80	90	95	100	100	100	100	100	100	100	100
Fugitive	20	27	40	50	60	70	85	95	100	100	100	100	100	100	100
5. Coke Oven															
Stack	20	35	45	55	70	85	95	100	100	100	100	100	100	100	100
Fugitive	5	10	35	50	65	85	95	100	100	100	100	100	100	100	100
6. Direct Reduction															
Stack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7. Blast Furnace															
Stack	90	90	90	90	95	100	100	100	100	100	100	100	100	100	100
Fugitive	0	0	0	5	10	20	80	95	100	100	100	100	100	100	100
8. Open Hearth Furnace															
Stack	25	35	50	50	75	100	100	100	100	100	100	100	100	100	100
Fugitive	0	0	0	0	25	50	75	100	100	100	100	100	100	100	100
9. Basic Oxygen Furnace															
Stack	50	57	66	75	85	95	95	100	100	100	100	100	100	100	100
Fugitive	0	0	20	35	40	70	90	95	100	100	100	100	100	100	100
10. Electric Furnace															
Stack	30	45	55	70	85	90	95	100	100	100	100	100	100	100	100
Fugitive	40	45	45	45	55	65	85	95	100	100	100	100	100	100	100
11. Ingot Casting															
Stack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12. Continuous Casting—Billets															
Stack	80	90	97	100	100	100	100	100	100	100	100	100	100	100	100
Fugitive	80	90	97	100	100	100	100	100	100	100	100	100	100	100	100
13. Continuous Casting—Slabs															
Stack	80	90	97	100	100	100	100	100	100	100	100	100	100	100	100
Fugitive	80	90	97	100	100	100	100	100	100	100	100	100	100	100	100
14. Primary Breakdown—Blooms															
Stack	40	65	75	80	90	95	95	100	100	100	100	100	100	100	100
Fugitive	40	65	75	80	90	95	95	100	100	100	100	100	100	100	100
15. Primary Breakdown—Billets															
Stack	40	65	75	80	90	95	95	100	100	100	100	100	100	100	100
Fugitive	40	65	75	80	90	95	95	100	100	100	100	100	100	100	100
16. Primary Breakdown—Slabs															
Stack	40	65	75	80	90	95	95	100	100	100	100	100	100	100	100
Fugitive	40	65	75	80	90	95	95	100	100	100	100	100	100	100	100
17. Heavy Structurals															
Stack	80	80	80	80	80	87	94	97	100	100	100	100	100	100	100
Fugitive	80	80	80	80	80	87	94	97	100	100	100	100	100	100	100
18. Bar Mill															
Stack	80	80	80	80	80	87	94	97	100	100	100	100	100	100	100
Fugitive	80	80	80	80	80	87	94	97	100	100	100	100	100	100	100
19. Wire Mill															
Stack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20. Cold Finished Bars															
Stack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21. Seamless Pipes															
Stack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22. Hot Strip Mill															
Stack	80	80	80	80	80	87	94	97	100	100	100	100	100	100	100
Fugitive	80	80	80	80	80	87	94	97	100	100	100	100	100	100	100
23. Pickling															
Stack	60	60	60	90	100	100	100	100	100	100	100	100	100	100	100
Fugitive	60	60	60	90	100	100	100	100	100	100	100	100	100	100	100
24. Welded Pipe															
Stack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25. Cold Reduction															
Stack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26. Galvanizing															
Stack	60	60	60	90	100	100	100	100	100	100	100	100	100	100	100
Fugitive	60	60	60	90	100	100	100	100	100	100	100	100	100	100	100
27. Tin Plating															
Stack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28. Plate Mill															
Stack	80	80	80	80	80	87	94	97	100	100	100	100	100	100	100
Fugitive	80	80	80	80	80	87	94	97	100	100	100	100	100	100	100
29. Auxiliary Facilities															
Stack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30. Vacuum Degassing															
Stack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: TBS in conjunction with the Division of Stationary Source Enforcement of EPA.

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Exhibit 11

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT BY PRODUCTION PROCESS AND TIME PERIOD

(millions of 1980 dollars)

SCENARIO 1

Process	1981 and Before	1982-1985	1986-1990	Total
Ore Yard	$ 18.4	$ 0.0	$ 0.0	$ 18.4
Coal Yard	8.1	0.4	0.0	8.5
Sintering	230.6	38.9	0.0	269.5
Coke Oven	1,969.1	206.9	0.0	2,176.0
Blast Furnace	710.1	126.6	10.5	847.2
Open Hearth	300.5	108.5	0.0	409.0
Basic Oxygen Furnace	418.0	45.2	0.0	463.2
Electric Furnace	566.0	77.2	91.7	734.9
Continuous Casting--Billets	23.3	11.5	57.0	91.8
Continuous Casting--Slabs	16.6	10.8	19.0	46.4
Primary Breakdown--Blooms	40.5	1.8	0.0	42.3
Primary Breakdown--Billets	20.4	0.9	0.0	21.3
Primary Breakdown--Slabs	63.3	2.9	0.0	66.2
Total	$4,384.9	$631.6	$178.1	$5,194.7

SCENARIO 2

Process	1981 and Before	1982-1985	1986-1990	Total
Ore Yard	$ 18.4	$ 0.0	$ 0.0	$ 18.4
Coal Yard	8.1	0.4	0.0	8.5
Sintering	230.6	38.9	0.0	269.5
Coke Oven	1,969.1	206.9	0.0	2,176.0
Blast Furnace	710.1	126.6	10.5	847.2
Open Hearth	300.5	108.5	0.0	409.0
Basic Oxygen Furnace	418.0	45.2	0.0	463.2
Electric Furnace	566.0	77.2	0.1	643.3
Continuous Casting--Billets	23.3	11.5	46.5	81.3
Continuous Casting--Slabs	16.6	10.8	0.0	27.4
Primary Breakdown--Blooms	40.5	1.8	0.0	42.3
Primary Breakdown--Billets	20.4	0.9	0.0	21.3
Primary Breakdown--Slabs	63.3	2.9	0.0	66.2
Total	$4,384.9	$631.6	$57.1	$5,073.6

Note: Costs may not add to totals due to rounding.

Source: PTm(Steel) and PEDCo/EPA engineering cost estimates.

Exhibit 12

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT BY PRODUCTION PROCESS AND TYPE OF EMISSION

(millions of 1980 dollars)

SCENARIO 1

Process	Stack	Fugitive	NSPS	Total
Ore Yard	$ 0.0	$ 11.8	$ 6.6	$ 18.4
Coal Yard	0.0	8.5	0.0	8.5
Sintering	194.7	74.8	0.0	269.5
Coke Oven	1,850.6	129.2	196.2	2,176.0
Blast Furnace	609.4	169.4	68.4	847.2
Open Hearth	176.1	232.9	0.0	409.0
Basic Oxygen Furnace	347.5	106.3	9.4	463.2
Electric Furnace	525.6	9.3	200.0	734.9
Continuous Casting--Billets	0.0	15.1	76.7	91.8
Continuous Casting--Slabs	0.0	11.8	34.6	46.4
Primary Breakdown--Blooms	0.0	42.3	0.0	42.3
Primary Breakdown--Billets	0.0	21.3	0.0	21.3
Primary Breakdown--Slabs	0.0	66.2	0.0	66.2
Total	$3,703.9	$898.9	$591.9	$5,194.7

SCENARIO 2

Process	Stack	Fugitive	NSPS	Total
Ore Yard	$ 0.0	$ 11.8	$ 6.6	$ 18.4
Coal Yard	0.0	8.5	0.0	8.5
Sintering	194.7	74.8	0.0	269.5
Coke Oven	1,850.6	129.2	196.2	2,176.0
Blast Furnace	609.4	169.4	68.4	847.2
Open Hearth	176.1	232.9	0.0	409.0
Basic Oxygen Furnace	347.5	106.3	9.4	463.2
Electric Furnace	525.6	9.3	108.4	643.3
Continuous Casting--Billets	0.0	15.1	66.2	81.3
Continuous Casting--Slabs	0.0	11.8	15.6	27.4
Primary Breakdown--Blooms	0.0	42.3	0.0	42.3
Primary Breakdown--Billets	0.0	21.3	0.0	21.3
Primary Breakdown--Slabs	0.0	66.2	0.0	66.2
Total	$3,703.9	$898.9	$470.8	$5,073.6

Note: Costs may not add to totals due to rounding.

Source: PTm(Steel) and PEDCo/EPA engineering cost estimates.

Exhibit 13

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT BY YEAR AND TYPE OF EMISSION

(millions of 1980 dollars)

SCENARIO 1

Year	Stack	Fugitive	NSPS	Total
1976 and Before	$1,389.2	$103.3	$ 0.0	$1,492.5
1977	545.6	61.0	0.0	606.6
1978	448.9	101.9	0.0	550.8
1979	327.2	66.4	73.7	467.3
1980	456.3	117.5	136.7	710.5
1981	359.9	147.2	50.1	557.2
1982	113.0	186.7	76.1	375.8
1983	63.8	100.1	66.4	230.3
1984	0.0	14.8	7.8	22.6
1985	0.0	0.0	2.9	2.9
1986	0.0	0.0	46.9	46.9
1987	0.0	0.0	66.1	66.1
1988	0.0	0.0	12.8	12.8
1989	0.0	0.0	39.4	39.4
1990	0.0	0.0	13.0	13.0
Total	$3,703.9	$898.9	$591.9	$5,194.7

SCENARIO 2

Year	Stack	Fugitive	NSPS	Total
1976 and Before	$1,389.2	$103.3	$ 0.0	$1,492.5
1977	545.6	61.0	0.0	606.6
1978	448.9	101.9	0.0	550.8
1979	327.2	66.4	73.7	467.3
1980	456.3	117.5	136.7	710.5
1981	359.9	147.2	50.1	557.2
1982	113.0	186.7	76.2	375.9
1983	63.8	100.1	59.8	223.7
1984	0.0	14.8	14.3	29.1
1985	0.0	0.0	2.9	2.9
1986	0.0	0.0	0.0	0.0
1987	0.0	0.0	8.3	8.3
1988	0.0	0.0	12.9	12.9
1989	0.0	0.0	28.9	28.9
1990	0.0	0.0	7.0	7.0
Total	$3,703.9	$898.9	$470.8	$5,073.6

Note: Costs may not add to totals due to rounding.

Source: PTm(Steel) and PEDCo/EPA engineering cost estimates.

Exhibit 14

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT BY PRODUCTION PROCESS

1980, 1985, and 1990

(millions of 1980 dollars)

SCENARIO 1

Process	1980	1985	1990
Ore Yard	$ 12.6	$ 16.4	$ 16.8
Coal Yard	3.9	5.4	5.4
Sintering	25.1	44.9	48.9
Coke Oven	168.6	288.4	291.7
Blast Furnace	44.3	88.4	96.2
Open Hearth	14.2	42.4	41.8
Basic Oxygen Furnace	45.9	82.1	90.8
Electric Furnace	86.5	160.1	184.1
Continuous Casting--Billets	3.7	6.8	20.6
Continuous Casting--Slabs	1.6	2.3	10.4
Primary Breakdown--Blooms	2.0	3.3	1.6
Primary Breakdown--Billets	1.2	1.8	1.3
Primary Breakdown--Slabs	3.3	5.4	3.4
Total	$412.9	$747.7	$813.0

SCENARIO 2

Process	1980	1985	1990
Ore Yard	$ 12.6	$ 15.4	$ 16.0
Coal Yard	3.9	5.1	5.1
Sintering	25.1	42.2	46.4
Coke Oven	168.6	270.5	277.0
Blast Furnace	44.3	83.0	91.3
Open Hearth	14.2	39.8	39.6
Basic Oxygen Furnace	45.9	77.1	86.2
Electric Furnace	86.5	150.1	170.9
Continuous Casting--Billets	3.7	6.1	19.0
Continuous Casting--Slabs	1.6	5.2	5.8
Primary Breakdown--Blooms	2.0	3.2	1.5
Primary Breakdown--Billets	1.2	1.8	1.2
Primary Breakdown--Slabs	3.3	3.8	4.4
Total	$412.9	$703.3	$764.4

Note: Costs may not add to totals due to rounding.

Source: PTm(Steel) and PEDCo/EPA engineering cost estimates.

Exhibit 15

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT BY YEAR AND TYPE OF EMISSION

(millions of 1980 dollars)

SCENARIO 1

Year	Stack	Fugitive	NSPS	Total
1976	$136.9	$ 10.5	$ 0.0	$147.4
1977	203.6	23.7	0.0	227.3
1978	264.9	52.1	0.0	317.0
1979	307.5	71.3	13.5	392.3
1980	304.1	77.2	31.6	412.9
1981	373.1	108.1	44.3	525.5
1982	414.4	146.0	63.9	624.3
1983	458.5	174.1	82.7	715.3
1984	465.7	176.6	86.1	728.4
1985	476.8	180.1	90.8	747.7
1986	473.4	179.1	106.3	758.8
1987	466.6	175.6	129.9	772.1
1988	468.9	178.9	135.2	783.0
1989	470.5	180.1	145.7	796.3
1990	478.1	183.5	151.4	813.0

SCENARIO 2

Year	Stack	Fugitive	NSPS	Total
1976	$136.9	$ 10.5	$ 0.0	$147.4
1977	203.6	23.7	0.0	227.3
1978	264.9	52.1	0.0	317.0
1979	307.5	71.3	13.5	392.3
1980	304.1	77.2	31.6	412.9
1981	370.0	107.4	44.2	521.6
1982	404.1	142.5	62.8	609.4
1983	429.3	163.6	77.2	670.1
1984	447.6	169.8	84.7	702.1
1985	447.3	169.0	87.0	703.3
1986	436.1	163.0	87.4	686.5
1987	418.3	151.7	90.1	660.1
1988	443.2	163.1	99.4	705.7
1989	474.0	175.8	113.7	763.5
1990	472.7	176.2	115.5	764.4

Note: Costs may not add to totals due to rounding.

Source: PTm(Steel) and PEDCo/EPA engineering cost estimates.

Exhibit 16

CAPITAL EXPENDITURES AND OPERATIONS AND MAINTENANCE EXPENSES FOR MISCELLANEOUS POLLUTION CONTROLS

(millions of 1980 dollars)

	Scenario 1		Scenario 2	
Year	Capital Expenditures	Operations and Maintenance Expenses	Capital Expenditures	Operations and Maintenance Expenses
1976	\$145.8[a]	\$33.2	\$145.8[a]	\$33.2
1977	38.9	44.1	38.9	44.1
1978	51.9	57.9	51.9	57.9
1979	88.1	82.0	88.1	82.0
1980	34.5	96.9	34.5	96.9
1981	5.6	96.7	4.5	96.3
1982	23.3	108.3	18.1	106.3
1983	43.1	128.0	23.9	119.1
1984	0.0	133.5	0.0	124.1
1985	0.0	138.7	0.0	129.0
1986	0.0	143.3	0.0	133.2
1987	0.0	147.2	0.0	137.0
1988	0.0	150.1	0.0	139.6
1989	0.0	153.1	0.0	142.4
1990	0.0	155.8	0.0	145.0
Total	\$431.2		\$405.7	

[a] Includes capital expenditures in 1976 and before.

Source: PTm(Steel).

Exhibit 17

SENSITIVITY ANALYSIS--AIR STRETCHOUT CAPITAL EXPENDITURES AND OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT

(millions of 1980 dollars)

Year	Capital Expenditures		Operations and Maintenance Expenses	
	Scenario 1	Sensitivity	Scenario 1	Sensitivity
1976	$1,492.5[a]	$1,492.5[a]	$147.4	$147.4
1977	606.6	606.6	227.3	227.3
1978	550.8	550.8	317.0	317.0
1979	467.3	467.3	392.3	392.3
1980	710.5	710.5	412.9	412.9
1981	557.5	320.7	525.5	496.9
1982	375.8	228.9	624.3	571.2
1983	230.3	159.3	715.3	644.1
1984	22.6	16.3	728.4	656.1
1985	2.9	335.1	747.7	747.7
1986	46.8	46.8	758.8	758.8
1987	66.1	66.1	772.1	772.1
1988	12.8	12.8	783.0	783.0
1989	39.4	39.4	796.3	796.3
1990	13.0	13.0	813.0	813.0
Total	$5,194.7	$5,066.1	N/A	N/A

Note: Costs may not add to totals due to rounding.

N/A = Not applicable.

[a] Capital expenditures include expenditures before 1976.

Source: PTm(Steel).

Exhibit 18

CAPITAL EXPENDITURES
FOR WATER POLLUTION CONTROL EQUIPMENT
BY YEAR AND EFFLUENT GUIDELINE

(millions of 1980 dollars)

SCENARIO 1

Year	BPT	BAT	PSES	NSPS	Total
1976 and Before	$1,179.6	$14.0	$20.6	$0.0	$1,214.2
1977	146.4	1.3	3.1	0.0	150.8
1978	106.6	0.5	1.0	0.0	108.1
1979	108.1	3.4	30.7	0.0	142.2
1980	134.5	4.1	32.3	0.0	170.9
1981	96.4	3.1	29.1	0.0	128.6
1982	61.8	24.1	8.3	39.0	133.2
1983	74.8	22.9	8.7	46.3	152.7
1984	76.6	23.1	9.3	61.2	170.2
1985	0.0	0.0	0.0	6.9	6.9
1986	0.0	0.0	0.0	26.9	26.9
1987	0.0	0.0	0.0	38.8	38.8
1988	0.0	0.0	0.0	30.4	30.4
1989	0.0	0.0	0.0	117.5	117.5
1990	0.0	0.0	0.0	53.5	53.5
Total	$1,984.8	$96.5	$143.1	$420.5	$2,644.9

SCENARIO 2

Year	BPT	BAT	PSES	NSPS	Total
1976 and Before	$1,179.6	$14.0	$20.6	$0.0	$1,214.2
1977	146.4	1.3	3.1	0.0	150.8
1978	106.6	0.5	1.0	0.0	108.1
1979	108.1	3.4	30.7	0.0	142.2
1980	134.5	4.1	32.3	0.0	170.9
1981	96.4	3.1	29.1	0.0	128.6
1982	61.8	24.1	8.3	39.0	133.2
1983	74.8	22.9	8.7	30.7	137.1
1984	76.6	23.1	9.3	76.6	185.6
1985	0.0	0.0	0.0	6.9	6.9
1986	0.0	0.0	0.0	0.0	0.0
1987	0.0	0.0	0.0	19.7	19.7
1988	0.0	0.0	0.0	30.4	30.4
1989	0.0	0.0	0.0	53.2	53.2
1990	0.0	0.0	0.0	16.7	16.7
Total	$1,984.8	$96.5	$143.1	$273.2	$2,497.6

Note: Costs may not add to totals due to rounding.

Source: PTm(Steel) and Rice/EPA engineering cost estimates.

Exhibit 19

CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT BY SUBCATEGORY AND EFFLUENT GUIDELINE

(millions of 1980 dollars)

SCENARIO I

Page 1 of 4

Subcategory	BPT			BAT			PSES			NSPS			Total		
	In Place	Required	Total	In Place	Required	Total	In Place	Required	Total	In Place	Required	Total	In Place	Required	Total
Raw Materials Preparation															
1. Cokemaking - Iron and Steel	$118.3	$47.9	$166.2	$11.1	$27.2	$38.3	$22.1	$3.4	$25.6	$0.0	$14.6	$14.6	$151.6	$93.1	$244.7
2. Cokemaking - Merchant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Sintering	53.9	4.1	58.0	0.6	5.3	5.8	3.1	0.3	3.5	0.0	0.0	0.0	57.6	9.7	67.3
Ironmaking															
4. Blast Furnace	498.4	24.8	523.2	10.1	25.9	36.0	17.5	0.4	17.9	0.0	9.5	9.5	526.1	60.5	586.5
Steelmaking															
5. Basic Oxygen Furnace - Semi-Wet	4.2	2.4	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	2.4	6.6
6. Basic Oxygen Furnace - Wet	21.6	0.0	21.6	1.6	0.4	2.0	4.1	0.0	4.1	0.0	0.0	0.0	27.2	0.4	27.6
7. Basic Oxygen Furnace - Open Combustion	77.0	1.6	78.6	0.9	6.1	7.0	6.7	0.0	6.7	0.0	0.0	0.0	84.7	7.7	92.4
8. Open Hearth Furnace - Wet	27.4	0.0	27.4	0.5	1.4	1.9	0.0	0.0	0.0	0.0	0.0	0.0	27.9	1.4	29.3
9. Electric Furnace - Semi-Wet	0.9	0.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.9	0.5	1.4
10. Electric Furnace - Wet	18.1	0.0	18.1	0.5	1.2	1.8	3.6	0.0	3.6	0.0	5.4	5.4	22.3	6.6	28.9
11. Vacuum Degassing	28.2	9.0	37.2	0.0	1.0	1.0	0.0	0.0	0.0	0.0	2.6	2.6	28.2	12.6	40.8
Casting															
12. Continuous Casting	94.6	6.9	101.5	0.6	0.9	1.5	10.4	0.1	10.6	0.0	345.4	345.4	105.6	353.3	458.9
Hot Forming															
13. Primary - No Scarfers - Carbon	40.1	9.4	49.5	0.0	0.0	0.0	1.1	0.0	1.1	0.0	0.0	0.0	41.2	9.4	50.6
14. Primary - Scarfers - Carbon	83.5	17.7	101.2	0.0	0.0	0.0	6.1	0.5	6.6	0.0	0.0	0.0	89.6	18.2	107.8
15. Primary - No Scarfers - Specialty	9.5	0.6	10.1	0.0	0.0	0.0	0.4	0.1	0.5	0.0	0.0	0.0	9.9	0.7	10.6
16. Primary - Scarfers - Specialty	7.2	0.0	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2	0.0	7.2
17. Section - Carbon	143.8	20.1	163.9	0.0	0.0	0.0	11.5	2.0	13.5	0.0	9.1	9.1	155.3	31.2	186.5
18. Section - Specialty	14.6	2.8	17.4	0.0	0.0	0.0	0.4	0.0	0.4	0.0	0.5	0.5	15.0	3.3	18.3
19. Flat - Carbon - Strip/Sheet	118.7	22.9	141.7	0.0	0.0	0.0	6.8	0.0	6.8	0.0	4.2	4.2	125.5	27.1	152.6
20. Flat - Specialty - Strip/Sheet	9.5	0.2	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	9.5	0.5	10.0
21. Flat - Carbon - Plate	15.1	5.9	21.0	0.0	0.0	0.0	1.9	0.0	1.9	0.0	0.0	0.0	17.0	5.9	22.9
22. Flat - Specialty - Plate	3.9	0.2	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.2	4.1
23. Pipe & Tube - Carbon	14.8	9.0	23.8	0.0	0.0	0.0	0.7	0.0	0.7	0.0	11.4	11.4	15.5	20.4	36.0
24. Pipe & Tube - Specialty	6.5	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	3.8	6.5	3.8	10.3
Salt Bath Descaling															
25. Oxidizing - Batch - Sheet/Plate	0.9	0.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.2	1.2
26. Oxidizing - Batch - Rod/Wire	1.1	0.0	1.1	0.0	0.0	0.0	0.1	0.2	0.3	0.0	0.0	0.0	1.1	0.3	1.4
27. Oxidizing - Batch - Pipe & Tube	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	1.0	0.2	1.3
28. Oxidizing - Continuous	1.9	0.2	2.1	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.1	0.1	2.0	0.5	2.5
29. Reducing - Batch	0.8	0.1	0.9	0.0	0.0	0.0	0.1	0.2	0.3	0.0	0.0	0.0	0.8	0.3	1.1
30. Reducing - Continuous	0.6	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.6

(continued)

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Exhibit 19 (continued)

SCENARIO I

Subcategory	IPT			BAT			PSES			NSPS			Total		
	In Place	Required	Total	In Place	Required	Total	In Place	Required	Total	In Place	Required	Total	In Place	Required	Total
Alkaline Cleaning															
31. Batch	$13.3	$1.2	$14.4	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.4	$0.4	$15.3	$1.5	$16.8
32. Continuous	20.5	1.2	21.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	20.5	1.4	22.0
Cold Rolling															
33. Single Stand - Recirculation	1.7	1.1	2.8	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.1	0.1	1.7	2.0	3.6
34. Multi-Stand - Recirculation	9.0	3.1	12.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	9.0	4.1	13.1
35. Combination	10.6	0.0	10.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	10.6	0.3	10.9
36. Single Stand - Direct Application	7.2	0.6	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	7.2	0.7	7.8
37. Multi-Stand - Direct Application	10.5	3.7	14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	10.5	4.0	14.5
38. Cold Pipe & Tube - Water	5.7	1.2	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	5.7	1.5	7.2
39. Cold Pipe & Tube - Oil	5.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	5.0	0.3	5.2
Sulfuric Acid Pickling															
40. Strip/Sheet/Plate - Neutralization	42.8	4.2	47.0	0.0	0.0	0.0	0.7	0.9	1.6	0.0	0.0	0.0	43.5	5.1	48.6
41. Rod/Wire/Coil - Neutralization	17.3	0.6	17.9	0.0	0.0	0.0	5.8	5.0	10.8	0.0	0.0	0.0	23.1	5.6	28.6
42. Bar/Billet/Bloom - Neutralization	17.0	0.0	17.0	0.0	0.0	0.0	0.2	0.5	0.7	0.0	0.0	0.0	17.2	0.5	17.7
43. Pipe & Tube - Neutralization	15.0	1.3	16.3	0.0	0.0	0.0	3.5	2.3	5.8	0.0	0.0	0.0	18.5	3.6	22.1
44. Strip/Sheet/Plate - Acid Recovery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	3.1	0.0	3.1	3.1
45. Rod/Wire/Coil - Acid Recovery	3.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.6	3.0	1.6	4.6
46. Bar/Billet/Bloom - Acid Recovery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47. Pipe & Tube - Acid Recovery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	4.9	0.0	4.9	4.9
Hydrochloric Acid Pickling															
48. Strip/Sheet/Plate - Neutralization	54.1	2.2	56.3	0.0	0.0	0.0	3.8	0.0	3.8	0.0	0.0	0.0	57.8	2.3	60.1
49. Rod/Wire/Coil - Neutralization	3.3	0.1	3.4	0.0	0.0	0.0	0.9	2.3	3.2	0.0	0.0	0.0	4.2	2.4	6.6
50. Pipe & Tube - Neutralization	2.0	0.1	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.1	2.1
51. Strip/Sheet/Plate - Acid Regeneration	23.7	0.0	23.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.7	0.0	23.7
Combination Acid Pickling															
52. Batch - Strip/Sheet/Plate - Neutralization	6.7	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	6.7
53. Continuous - Strip/Sheet/Plate - Neutralization	29.4	0.1	29.5	0.0	0.0	0.0	0.1	0.8	0.9	0.0	0.0	0.0	29.4	0.9	30.4
54. Rod/Wire/Coil - Neutralization	11.1	0.2	11.4	0.0	0.0	0.0	0.9	1.2	2.1	0.0	0.3	0.3	12.0	1.8	13.7
55. Bar/Billet/Bloom - Neutralization	2.4	0.0	2.4	0.0	0.0	0.0	0.9	0.2	1.1	0.0	0.1	0.1	3.3	0.3	3.6
56. Pipe & Tube - Neutralization	7.7	0.9	8.6	0.0	0.0	0.0	0.5	1.5	2.0	0.0	0.0	0.0	8.2	2.4	10.6
Hot Coating															
57. Galvanizing - No Scrubbers - Strip/Sheet/Misc.	12.7	1.7	14.4	0.0	0.0	0.0	0.4	0.9	1.2	0.0	0.4	0.4	13.1	3.0	16.1
58. Galvanizing - Scrubbers - Strip/Sheet/Misc.	11.3	0.5	11.8	0.4	0.3	0.7	0.0	0.0	0.0	0.0	0.3	0.3	11.7	1.1	12.8
59. Galvanizing - No Scrubbers - Wire Prod./Fasteners	7.1	0.7	7.8	0.0	0.0	0.0	0.5	0.2	0.7	0.0	0.0	0.0	7.6	0.9	8.6
60. Galvanizing - Scrubbers - Wire Prod./Fasteners	2.5	0.7	3.2	0.2	0.0	0.3	1.9	1.1	3.0	0.0	0.0	0.0	4.6	1.8	6.4
61. Terne - No Scrubbers - Strip/Sheet/Misc.	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
62. Terne - Scrubbers - Strip/Sheet/Misc.	1.5	0.3	1.8	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.5	2.0
63. Other Metals - No Scrubbers - Strip/Sheet/Misc.	0.9	1.1	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.1	2.0
64. Other Metals - Scrubbers - Strip/Sheet/Misc.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65. Other Metals - No Scrubbers - Wire Prod./Fasteners	0.5	0.0	0.5	0.0	0.0	0.0	0.1	0.3	0.4	0.0	0.0	0.0	0.6	0.3	0.9
66. Other Metals - Scrubbers - Wire Prod./Fasteners	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	$1,771.6	$213.2	$1,984.8	$26.4	$70.1	$96.5	$116.8	$26.3	$143.1	$0.0	$420.5	$420.5	$1,914.8	$730.1	$2,644.9

(continued)

Exhibit 19 (continued)

SCENARIO 2

Subcategory	BPT			BAT			PSES			NSPS			Total		
	In Place	Required	Total	In Place	Required	Total	In Place	Required	Total	In Place	Required	Total	In Place	Required	Total
Raw Materials Preparation															
1. Cokemaking - Iron and Steel	$118.3	$47.9	$166.2	$11.1	$27.2	$38.3	$22.1	$3.4	$25.6	$0.0	$14.6	$14.6	$151.6	$93.1	$244.7
2. Cokemaking - Merchant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Sintering	53.9	4.1	58.0	0.6	5.3	5.8	3.1	0.3	3.5	0.0	0.0	0.0	57.6	9.7	67.3
Ironmaking															
4. Blast Furnace	498.4	24.8	523.2	10.1	25.9	36.0	17.5	0.4	17.9	0.0	9.5	9.5	526.1	60.5	586.5
Steelmaking															
5. Basic Oxygen Furnace - Semi-Wet	4.2	2.4	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	2.4	6.6
6. Basic Oxygen Furnace - Wet	21.6	0.0	21.6	1.6	0.4	2.0	4.1	0.0	4.1	0.0	0.0	0.0	27.2	0.4	27.6
7. Basic Oxygen Furnace - Open Combustion	77.0	1.6	78.6	0.9	6.1	7.0	6.7	0.0	6.7	0.0	0.0	0.0	84.7	7.7	92.4
8. Open Hearth Furnace - Wet	27.4	0.0	27.4	0.5	1.4	1.9	0.0	0.0	0.0	0.0	0.0	0.0	27.9	1.4	29.3
9. Electric Furnace - Semi-Wet	0.9	0.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.9	0.3	1.2
10. Electric Furnace - Wet	18.1	0.0	18.1	0.5	1.2	1.8	3.6	0.0	3.6	0.0	1.7	1.7	22.3	2.9	25.1
11. Vacuum Degassing	28.1	9.8	37.2	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	28.2	10.8	39.0
Casting															
12. Continuous Casting	94.6	6.9	101.5	0.6	0.9	1.5	10.4	0.1	10.6	0.0	203.9	203.9	105.6	211.8	317.4
Hot Forming															
13. Primary - No Scarfers - Carbon	40.1	9.4	49.5	0.0	0.0	0.0	1.1	0.0	1.1	0.0	0.0	0.0	41.2	9.4	50.6
14. Primary - Scarfers - Carbon	83.5	17.7	101.2	0.0	0.0	0.0	6.1	0.5	6.6	0.0	0.0	0.0	89.6	18.2	107.8
15. Primary - No Scarfers - Specialty	9.5	0.6	10.1	0.0	0.0	0.0	0.4	0.1	0.5	0.0	0.0	0.0	9.9	0.7	10.6
16. Primary - Scarfers - Specialty	7.2	0.0	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2	0.0	7.2
17. Section - Carbon	143.8	20.1	163.8	0.0	0.0	0.0	11.5	2.0	13.5	0.0	9.1	9.1	155.3	31.2	186.5
18. Section - Specialty	14.6	2.8	17.4	0.0	0.0	0.0	0.4	0.0	0.4	0.0	0.3	0.3	15.0	3.3	18.3
19. Flat - Carbon - Strip/Sheet	118.7	22.9	141.7	0.0	0.0	0.0	6.8	0.0	6.8	0.0	4.2	4.2	125.5	27.1	152.6
20. Flat - Specialty - Strip/Sheet	9.5	0.2	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	9.5	0.5	10.0
21. Flat - Carbon - Plate	15.1	5.9	21.0	0.0	0.0	0.0	1.9	0.0	1.9	0.0	0.0	0.0	17.0	5.9	22.9
22. Flat - Specialty - Plate	3.9	0.2	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.2	4.1
23. Pipe & Tube - Carbon	14.8	9.0	23.8	0.0	0.0	0.0	0.7	0.0	0.7	0.0	11.4	11.4	15.5	20.4	36.0
24. Pipe & Tube - Specialty	6.5	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	3.8	6.5	3.8	10.3
Salt Bath Descaling															
25. Oxidizing - Batch - Sheet/Plate	0.9	0.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.2	1.2
26. Oxidizing - Batch - Rod/Wire	1.1	0.0	1.1	0.0	0.0	0.0	0.1	0.2	0.3	0.0	0.0	0.0	1.1	0.3	1.4
27. Oxidizing - Batch - Pipe & Tube	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	1.0	0.2	1.3
28. Oxidizing - Continuous	1.9	0.2	2.1	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.1	0.1	2.0	0.5	2.5
29. Reducing - Batch	0.8	0.1	0.9	0.0	0.0	0.0	0.1	0.2	0.3	0.0	0.0	0.0	0.8	0.3	1.1
30. Reducing - Continuous	0.6	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.6

(continued)

V-34

Exhibit 19 (continued)

SCENARIO 2

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Subcategory	BPT			BAT			PSES			NSPS			Total		
	In Place	Required	Total	In Place	Required	Total	In Place	Required	Total	In Place	Required	Total	In Place	Required	Total
Alkaline Cleaning															
31. Batch	$5.3	$1.2	$6.4	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.4	$0.4	$5.3	$1.5	$6.8
32. Continuous	20.5	1.2	21.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	20.5	1.4	22.0
Cold Rolling															
33. Single Stand - Recirculation	1.7	1.1	2.8	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.1	0.1	1.7	2.0	3.6
34. Multi-Stand - Recirculation	9.0	3.1	12.1	0.0	0.0	0.0	0.0	0.8	0.8	0.0	0.2	0.2	9.0	4.1	13.1
35. Combination	10.6	0.0	10.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	10.6	0.3	10.9
36. Single Stand - Direct Application	7.2	0.6	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	7.2	0.7	7.8
37. Multi-Stand - Direct Application	10.5	3.7	14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	10.5	4.0	14.5
38. Cold Pipe & Tube - Water	5.7	1.2	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	5.7	1.5	7.2
39. Cold Pipe & Tube - Oil	5.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	5.0	0.3	5.2
Sulfuric Acid Pickling															
40. Strip/Sheet/Plate - Neutralization	42.8	4.2	47.0	0.0	0.0	0.0	0.7	0.9	1.6	0.0	0.0	0.0	43.5	5.1	48.6
41. Rod/Wire/Coil - Neutralization	17.3	0.6	17.9	0.0	0.0	0.0	5.8	5.0	10.8	0.0	0.0	0.0	23.1	5.6	28.6
42. Bar/Billet/Bloom - Neutralization	17.0	0.0	17.0	0.0	0.0	0.0	0.2	0.5	0.7	0.0	0.0	0.0	17.2	0.5	17.7
43. Pipe & Tube - Neutralization	15.0	1.3	16.3	0.0	0.0	0.0	3.5	2.3	5.8	0.0	0.0	0.0	18.5	3.6	22.1
44. Strip/Sheet/Plate - Acid Recovery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	3.1	0.0	3.1	3.1
45. Rod/Wire/Coil - Acid Recovery	3.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.6	3.0	1.6	4.6
46. Bar/Billet/Bloom - Acid Recovery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47. Pipe & Tube - Acid Recovery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	4.9	0.0	4.9	4.9
Hydrochloric Acid Pickling															
48. Strip/Sheet/Plate - Neutralization	54.1	2.2	56.3	0.0	0.0	0.0	3.8	0.0	3.8	0.0	0.0	0.0	57.8	2.3	60.1
49. Rod/Wire/Coil - Neutralization	3.3	0.1	3.4	0.0	0.0	0.0	0.9	2.3	3.2	0.0	0.0	0.0	4.2	2.4	6.6
50. Pipe & Tube - Neutralization	2.0	0.1	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.1	2.1
51. Strip/Sheet/Plate - Acid Regeneration	23.7	0.0	23.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.7	0.0	23.7
Combination Acid Pickling															
52. Batch - Strip/Sheet/Plate - Neutralization	6.7	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	6.7
53. Continuous - Strip/Sheet/Plate - Neutralization	29.4	0.1	29.5	0.0	0.0	0.0	0.1	0.8	0.9	0.0	0.0	0.0	29.4	0.9	30.4
54. Rod/Wire/Coil - Neutralization	11.1	0.2	11.4	0.0	0.0	0.0	0.9	1.2	2.1	0.0	0.3	0.3	12.0	1.8	13.7
55. Bar/Billet/Bloom - Neutralization	2.4	0.0	2.4	0.0	0.0	0.0	0.9	0.2	1.1	0.0	0.1	0.1	3.3	0.3	3.6
56. Pipe & Tube - Neutralization	7.7	0.9	8.6	0.0	0.0	0.0	0.5	1.5	2.0	0.0	0.0	0.0	8.2	2.4	10.6
Hot Coating															
57. Galvanizing - No Scrubbers - Strip/Sheet/Misc.	12.7	1.7	14.4	0.0	0.0	0.0	0.4	0.9	1.2	0.0	0.4	0.4	13.1	3.0	16.1
58. Galvanizing - Scrubbers - Strip/Sheet/Misc.	11.3	0.5	11.8	0.4	0.3	0.7	0.0	0.0	0.0	0.0	0.3	0.3	11.7	1.1	12.8
59. Galvanizing - No Scrubbers - Wire Prod./Fasteners	7.1	0.7	7.8	0.0	0.0	0.0	0.5	0.2	0.7	0.0	0.0	0.0	7.6	0.9	8.6
60. Galvanizing - Scrubbers - Wire Prod./Fasteners	2.5	0.7	3.2	0.2	0.0	0.3	1.9	1.1	3.0	0.0	0.0	0.0	4.6	1.8	6.4
61. Terne - No Scrubbers - Strip/Sheet/Misc.	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
62. Terne - Scrubbers - Strip/Sheet/Misc.	1.5	0.3	1.8	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.5	2.0
63. Other Metals - No Scrubbers - Strip/Sheet/Misc.	0.9	1.1	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.1	2.0
64. Other Metals - Scrubbers - Strip/Sheet/Misc.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65. Other Metals - No Scrubbers - Wire Prod./Fasteners	0.5	0.0	0.5	0.0	0.0	0.0	0.1	0.3	0.4	0.0	0.0	0.0	0.6	0.3	0.9
66. Other Metals - Scrubbers - Wire Prod./Fasteners	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	$1,771.6	$213.2	$1,984.8	$26.4	$70.1	$96.5	$116.8	$26.3	$143.1	$0.0	$275.2	$275.2	$1,914.8	$582.8	$2,497.6

Note: Costs may not add to totals due to rounding.

Source: PTm(Steel) and Rice/EPA engineering cost estimates.

Exhibit 20

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT BY YEAR AND EFFLUENT GUIDELINE

(millions of 1980 dollars)

SCENARIO 1

Year	BPT	BAT	PSES	NSPS	Total
1976 and Before	$ 30.4	$ 1.5	$ 0.8	$ 0.0	$ 32.7
1977	44.1	1.6	1.0	0.0	46.7
1978	53.4	1.7	1.0	0.0	56.1
1979	70.8	2.1	2.9	0.0	75.8
1980	84.9	2.1	4.5	0.0	91.5
1981	106.3	2.7	6.6	0.0	115.6
1982	116.0	5.9	7.9	5.1	134.9
1983	127.0	9.8	9.2	9.8	155.8
1984	125.0	12.9	9.9	12.1	159.9
1985	124.3	13.1	10.0	13.5	160.9
1986	122.5	13.1	10.1	16.5	162.2
1987	123.3	13.0	10.1	20.5	166.9
1988	130.1	13.4	10.3	24.7	178.5
1989	137.6	13.5	10.9	35.2	197.2
1990	142.1	13.7	11.3	40.7	207.8

SCENARIO 2

Year	BPT	BAT	PSES	NSPS	Total
1976 and Before	$ 30.4	$ 1.5	$ 0.8	$ 0.0	$ 32.7
1977	44.1	1.6	1.0	0.0	46.7
1978	53.4	1.7	1.0	0.0	56.1
1979	70.8	2.1	2.9	0.0	75.8
1980	84.9	2.1	4.5	0.0	91.5
1981	110.0	2.7	6.8	0.0	119.5
1982	118.9	5.8	8.0	5.6	138.3
1983	126.5	9.2	9.1	9.1	153.9
1984	133.1	12.5	10.2	14.9	170.7
1985	129.4	12.4	10.1	15.7	167.6
1986	120.2	11.9	9.7	15.6	157.4
1987	114.1	11.3	9.2	17.1	151.7
1988	119.5	12.2	9.6	20.3	161.6
1989	127.5	13.1	10.3	26.0	176.9
1990	126.9	13.0	10.4	27.8	178.1

Note: Costs may not add to totals due to rounding.

Source: PTm(Steel) and Rice/EPA engineering cost estimates.

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Exhibit 21

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT BY SUBCATEGORY AND EFFLUENT GUIDELINE

1985 and 1990

(millions of 1980 dollars)

SCENARIO 1

Page 1 of 4

	1985					1990				
Subcategory	BPT	BAT	PSES	NSPS	Total	BPT	BAT	PSES	NSPS	Total
Raw Materials Preparation										
1. Cokemaking - Iron and Steel	$22.9	$4.4	$3.4	$3.3	$34.2	$24.8	$4.7	$3.6	$3.8	$36.9
2. Cokemaking - Merchant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Sintering	8.3	0.3	0.4	0.0	9.0	8.7	0.3	0.4	0.0	9.5
Ironmaking										
4. Blast Furnace	22.4	7.4	0.6	0.0	30.4	15.2	7.5	0.5	0.6	23.7
Steelmaking										
5. Basic Oxygen Furnace - Semi-Wet	0.6	0.0	0.0	0.0	0.6	0.6	0.0	0.0	0.0	0.6
6. Basic Oxygen Furnace - Wet	3.4	0.1	0.7	0.0	4.2	3.6	0.1	0.7	0.0	4.4
7. Basic Oxygen Furnace - Open Combustion	11.3	0.5	1.1	0.1	13.0	12.1	0.6	1.2	0.1	14.0
8. Open Hearth Furnace - Wet	1.9	0.1	0.0	0.0	2.1	1.8	0.1	0.0	0.0	1.9
9. Electric Furnace - Semi-Wet	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.2
10. Electric Furnace - Wet	3.8	0.1	0.7	0.6	5.3	3.5	0.1	0.7	1.4	5.7
11. Vacuum Degassing	2.6	0.1	0.0	0.1	2.7	2.8	0.1	0.0	0.3	3.1
Casting										
12. Continuous Casting	5.9	0.1	0.6	4.9	11.4	10.8	0.1	0.8	30.0	41.7
Hot Forming										
13. Primary - No Scarfers - Carbon	-8.7	0.0	-0.1	0.0	-8.8	-5.9	0.0	-0.1	0.0	-6.0
14. Primary - Scarfers - Carbon	-32.4	0.0	-2.1	0.0	-34.6	-21.9	0.0	-1.4	0.0	-23.4
15. Primary - No Scarfers - Specialty	-0.5	0.0	0.0	0.0	-0.5	-0.4	0.0	0.0	0.0	-0.4
16. Primary - Scarfers - Specialty	-1.2	0.0	0.0	0.0	-1.2	-0.7	0.0	0.0	0.0	-0.7
17. Section - Carbon	-3.0	0.0	-0.3	0.1	-3.2	-3.9	0.0	-0.4	0.0	-4.3
18. Section - Specialty	-0.5	0.0	0.0	0.0	-0.5	-0.6	0.0	0.0	0.0	-0.6
19. Flat - Carbon - Strip/Sheet	-8.3	0.0	-0.3	0.0	-8.6	-11.9	0.0	-0.4	0.0	-12.4
20. Flat - Specialty - Strip/Sheet	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.1
21. Flat - Carbon - Plate	-1.6	0.0	-0.2	0.0	-1.8	-2.2	0.0	-0.2	0.0	-2.4
22. Flat - Specialty - Plate	-0.2	0.0	0.0	0.0	-0.2	-0.3	0.0	0.0	0.0	-0.3
23. Pipe & Tube - Carbon	1.4	0.0	0.0	0.6	2.0	1.5	0.0	0.0	0.7	2.2
24. Pipe & Tube - Specialty	0.1	0.0	0.0	0.1	0.3	0.1	0.0	0.0	0.1	0.3
Salt Bath Descaling										
25. Oxidizing - Batch - Sheet/Plate	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
26. Oxidizing - Batch - Rod/Wire	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
27. Oxidizing - Batch - Pipe & Tube	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
28. Oxidizing - Continuous	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.2
29. Reducing - Batch	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30. Reducing - Continuous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(continued)

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Exhibit 21 (continued)

SCENARIO 1

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Subcategory	1985 BPT	1985 BAT	1985 PSES	1985 NSPS	1985 Total	1990 BPT	1990 BAT	1990 PSES	1990 NSPS	1990 Total
Alkaline Cleaning										
31. Batch	$0.3	$0.0	$0.0	$0.0	$0.3	$0.3	$0.0	$0.0	$0.0	$0.3
32. Continuous	1.2	0.0	0.0	0.0	1.2	1.4	0.0	0.0	0.0	1.4
Cold Rolling										
33. Single Stand - Recirculation	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.2
34. Multi-Stand - Recirculation	-0.4	0.0	0.0	0.0	-0.4	-0.9	0.0	0.0	0.0	-0.9
35. Combination	1.2	0.0	0.0	0.0	1.2	1.1	0.0	0.0	0.0	1.1
36. Single Stand - Direct Application	0.3	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.3
37. Multi-Stand - Direct Application	0.7	0.0	0.0	0.0	0.7	0.6	0.0	0.0	0.0	0.6
38. Cold Pipe & Tube - Water	0.3	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.3
39. Cold Pipe & Tube - Oil	0.2	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.2
Sulfuric Acid Pickling										
40. Strip/Sheet/Plate - Neutralization	29.8	0.0	0.3	0.0	30.1	32.5	0.0	0.3	0.0	32.8
41. Rod/Wire/Coil - Neutralization	4.0	0.0	1.8	0.0	5.8	4.4	0.0	2.0	0.0	6.4
42. Bar/Billet/Bloom - Neutralization	4.2	0.0	0.1	0.0	4.3	4.0	0.0	0.1	0.0	4.1
43. Pipe & Tube - Neutralization	4.0	0.0	0.6	0.0	4.6	4.2	0.0	0.6	0.0	4.8
44. Strip/Sheet/Plate - Acid Recovery	0.0	0.0	0.0	1.5	1.5	0.0	0.0	0.0	1.6	1.6
45. Rod/Wire/Coil - Acid Recovery	0.1	0.0	0.0	0.3	0.4	0.1	0.0	0.0	0.4	0.4
46. Bar/Billet/Bloom - Acid Recovery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47. Pipe & Tube - Acid Recovery	0.0	0.0	0.0	1.3	1.3	0.0	0.0	0.0	1.4	1.4
Hydrochloric Acid Pickling										
48. Strip/Sheet/Plate - Neutralization	37.7	0.0	1.5	0.0	39.2	41.6	0.0	1.7	0.0	43.3
49. Rod/Wire/Coil - Neutralization	0.4	0.0	0.4	0.0	0.7	0.3	0.0	0.3	0.0	0.7
50. Pipe & Tube - Neutralization	0.3	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.3
51. Strip/Sheet/Plate - Acid Regeneration	-4.8	0.0	0.0	0.0	-4.8	-4.8	0.0	0.0	0.0	-4.8
Combination Acid Pickling										
52. Batch - Strip/Sheet/Plate - Neutralization	0.9	0.0	0.0	0.0	0.9	0.9	0.0	0.0	0.0	0.9
53. Continuous - Strip/Sheet/Plate - Neutralization	8.5	0.0	0.0	0.0	8.6	9.4	0.0	0.0	0.0	9.5
54. Rod/Wire/Coil - Neutralization	2.0	0.0	0.1	0.0	2.2	2.2	0.0	0.2	0.0	2.4
55. Bar/Billet/Bloom - Neutralization	0.3	0.0	0.3	0.0	0.6	0.4	0.0	0.3	0.0	0.7
56. Pipe & Tube - Neutralization	1.4	0.0	0.1	0.0	1.5	1.5	0.0	0.1	0.0	1.6
Hot Coating										
57. Galvanizing - No Scrubbers - Strip/Sheet/Misc.	1.1	0.0	0.1	0.0	1.2	1.3	0.0	0.1	0.0	1.4
58. Galvanizing - Scrubbers - Strip/Sheet/Misc.	1.0	0.0	0.0	0.0	1.0	1.1	0.1	0.0	0.0	1.2
59. Galvanizing - No Scrubbers - Wire Prod./Fasteners	0.3	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.3
60. Galvanizing - Scrubbers - Wire Prod./Fasteners	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.2
61. Terne - No Scrubbers - Strip/Sheet/Misc.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
62. Terne - Scrubbers - Strip/Sheet/Misc.	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
63. Other Metals - No Scrubbers - Strip/Sheet/Misc.	0.1	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.2
64. Other Metals - Scrubbers - Strip/Sheet/Misc.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65. Other Metals - No Scrubbers - Wire Prod./Fasteners	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
66. Other Metals - Scrubbers - Wire Prod./Fasteners	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	$124.3	$13.1	$10.0	$13.5	$160.9	$142.1	$13.7	$11.3	$40.7	$207.8

(continued)

Exhibit 21 (continued)

SCENARIO 2

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Subcategory	1985 BPT	1985 BAT	1985 PSES	1985 NSPS	1985 Total	1990 BPT	1990 BAT	1990 PSES	1990 NSPS	1990 Total
Raw Materials Preparation										
1. Cokemaking - Iron and Steel	$21.5	$4.1	$3.2	$3.3	$32.1	$23.5	$4.5	$3.4	$3.6	$35.1
2. Cokemaking - Merchant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Sintering	7.8	0.3	0.4	0.0	8.4	8.3	0.3	0.4	0.0	9.0
Ironmaking										
4. Blast Furnace	21.0	6.9	0.6	0.0	28.6	14.4	7.1	0.3	0.6	22.3
Steelmaking										
5. Basic Oxygen Furnace - Semi-Wet	0.5	0.0	0.0	0.0	0.5	0.6	0.0	0.0	0.0	0.6
6. Basic Oxygen Furnace - Wet	3.2	0.1	0.6	0.0	3.9	3.4	0.1	0.7	0.0	4.2
7. Basic Oxygen Furnace - Open Combustion	10.6	0.5	1.0	0.1	12.2	11.5	0.5	1.1	0.1	13.3
8. Open Hearth Furnace - Wet	1.3	0.1	0.0	0.0	1.9	1.7	0.1	0.0	0.0	1.8
9. Electric Furnace - Semi-Wet	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.2
10. Electric Furnace - Wet	3.6	0.1	0.7	0.6	5.0	3.9	0.1	0.7	0.7	5.4
11. Vacuum Degassing	2.4	0.0	0.0	0.1	2.6	2.8	0.1	0.0	0.1	3.0
Casting										
12. Continuous Casting	9.5	0.1	0.7	7.6	17.9	11.1	0.1	0.9	18.6	30.7
Hot Forming										
13. Primary - No Scarfers - Carbon	-7.0	0.0	-0.1	0.0	-7.1	-6.9	0.0	-0.1	0.0	-7.1
14. Primary - Scarfers - Carbon	-24.3	0.0	-1.6	0.0	-25.9	-27.6	0.0	-1.8	0.0	-29.4
15. Primary - No Scarfers - Specialty	-0.4	0.0	0.0	0.0	-0.4	-0.5	0.0	0.0	0.0	-0.5
16. Primary - Scarfers - Specialty	-1.1	0.0	0.0	0.0	-1.1	-0.7	0.0	0.0	0.0	-0.7
17. Section - Carbon	-2.9	0.0	-0.3	0.1	-3.2	-3.6	0.0	-0.4	0.0	-4.0
18. Section - Specialty	-0.5	0.0	0.0	0.0	-0.5	-0.5	0.0	0.0	0.0	-0.5
19. Flat - Carbon - Strip/Sheet	-7.9	0.0	-0.3	0.0	-8.2	-11.1	0.0	-0.4	0.0	-11.6
20. Flat - Specialty - Strip/Sheet	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
21. Flat - Carbon - Plate	-1.5	0.0	-0.2	0.0	-1.7	-2.1	0.0	-0.2	0.0	-2.3
22. Flat - Specialty - Plate	-0.2	0.0	0.0	0.0	-0.2	-0.3	0.0	0.0	0.0	-0.3
23. Pipe & Tube - Carbon	1.3	0.0	0.0	0.6	2.0	1.4	0.0	0.0	0.6	2.1
24. Pipe & Tube - Specialty	0.1	0.0	0.0	0.1	0.3	0.1	0.0	0.0	0.1	0.2
Salt Bath Descaling										
25. Oxidizing - Batch - Sheet/Plate	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
26. Oxidizing - Batch - Rod/Wire	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
27. Oxidizing - Batch - Pipe & Tube	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
28. Oxidizing - Continuous	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.2
29. Reducing - Batch	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30. Reducing - Continuous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(continued)

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Exhibit 21 (continued)

SCENARIO 2

Subcategory	1985 BPT	1985 BAT	1985 PSES	1985 NSPS	1985 Total	1990 BPT	1990 BAT	1990 PSES	1990 NSPS	1990 Total
Alkaline Cleaning										
31. Batch	$0.2	$0.0	$0.0	$0.0	$0.3	$0.3	$0.0	$0.0	$0.0	$0.3
32. Continuous	1.1	0.0	0.0	0.0	1.2	1.3	0.0	0.0	0.0	1.3
Cold Rolling										
33. Single Stand - Recirculation	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.2
34. Multi-Stand - Recirculation	-0.3	0.0	0.0	0.0	-0.4	-0.8	0.0	0.0	0.0	-0.9
35. Combination	1.1	0.0	0.0	0.0	1.1	1.0	0.0	0.0	0.0	1.0
36. Single Stand - Direct Application	0.3	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.3
37. Multi-Stand - Direct Application	0.6	0.0	0.0	0.0	0.6	0.5	0.0	0.0	0.0	0.5
38. Cold Pipe & Tube - Water	0.3	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.3
39. Cold Pipe & Tube - Oil	0.2	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.2
Sulfuric Acid Pickling										
40. Strip/Sheet/Plate - Neutralization	28.3	0.0	0.3	0.0	28.7	30.3	0.0	0.3	0.0	30.6
41. Rod/Wire/Coil - Neutralization	3.8	0.0	1.8	0.0	5.6	4.1	0.0	1.9	0.0	6.0
42. Bar/Billet/Bloom - Neutralization	4.0	0.0	0.1	0.0	4.2	3.7	0.0	0.1	0.0	3.9
43. Pipe & Tube - Neutralization	3.8	0.0	0.6	0.0	4.4	3.9	0.0	0.6	0.0	4.5
44. Strip/Sheet/Plate - Acid Recovery	0.0	0.0	0.0	1.4	1.4	0.0	0.0	0.0	1.5	1.5
45. Rod/Wire/Coil - Acid Recovery	0.1	0.0	0.0	0.3	0.4	0.1	0.0	0.0	0.3	0.4
46. Bar/Billet/Bloom - Acid Recovery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47. Pipe & Tube - Acid Recovery	0.0	0.0	0.0	1.3	1.3	0.0	0.0	0.0	1.3	1.3
Hydrochloric Acid Pickling										
48. Strip/Sheet/Plate - Neutralization	36.0	0.0	1.5	0.0	37.5	38.8	0.0	1.6	0.0	40.4
49. Rod/Wire/Coil - Neutralization	0.4	0.0	0.4	0.0	0.7	0.3	0.0	0.3	0.0	0.6
50. Pipe & Tube - Neutralization	0.3	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.3
51. Strip/Sheet/Plate - Acid Regeneration	-4.6	0.0	0.0	0.0	-4.6	-4.5	0.0	0.0	0.0	-4.5
Combination Acid Pickling										
52. Batch - Strip/Sheet/Plate - Neutralization	0.8	0.0	0.0	0.0	0.8	0.9	0.0	0.0	0.0	0.9
53. Continuous - Strip/Sheet/Plate - Neutralization	8.1	0.0	0.0	0.0	8.2	8.8	0.0	0.0	0.0	8.8
54. Rod/Wire/Coil - Neutralization	2.0	0.0	0.1	0.0	2.1	2.1	0.0	0.2	0.0	2.3
55. Bar/Billet/Bloom - Neutralization	0.3	0.0	0.3	0.0	0.6	0.3	0.0	0.3	0.0	0.6
56. Pipe & Tube - Neutralization	1.4	0.0	0.1	0.0	1.5	1.4	0.0	0.1	0.0	1.5
Hot Coating										
57. Galvanizing - No Scrubbers - Strip/Sheet/Misc.	1.1	0.0	0.1	0.0	1.2	1.3	0.0	0.1	0.0	1.3
58. Galvanizing - Scrubbers - Strip/Sheet/Misc.	0.9	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	1.1
59. Galvanizing - No Scrubbers - Wire Prod./Fasteners	0.3	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.3
60. Galvanizing - Scrubbers - Wire Prod./Fasteners	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.2
61. Terne - No Scrubbers - Strip/Sheet/Misc.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
62. Terne - Scrubbers - Strip/Sheet/Misc.	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
63. Other Metals - No Scrubbers - Strip/Sheet/Misc.	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
64. Other Metals - Scrubbers - Strip/Sheet/Misc.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65. Other Metals - No Scrubbers - Wire Prod./Fasteners	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
66. Other Metals - Scrubbers - Wire Prod./Fasteners	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	$129.4	$12.4	$10.1	$15.7	$167.6	$126.9	$13.0	$10.4	$27.8	$178.1

Note: Costs may not add to totals due to rounding.

Source: PTm(Steel) and Rice/EPA engineering cost estimates.

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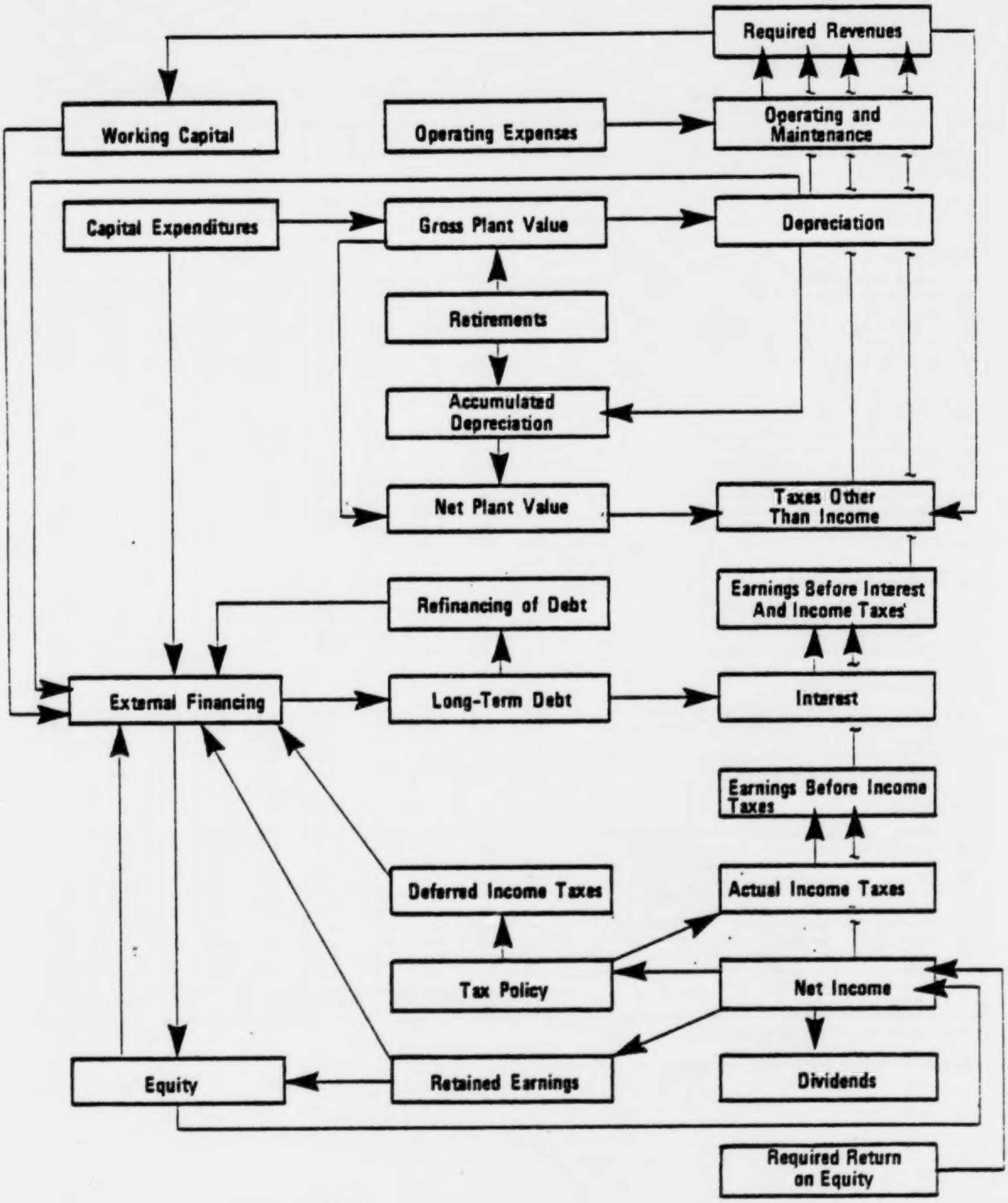
Exhibit 22

PTm(Steel) FINANCIAL MODULE


Required Revenues
Working Capital
Operating Expenses
Operating and Maintenance
Capital Expenditures
Gross Plant Value
Depreciation
Retirements
Accumulated Depreciation
Net Plant Value
Taxes Other Than Income
Refinancing of Debt
Earnings Before Interest And Income Taxes
External Financing
Long-Term Debt
Interest
Earnings Before Income Taxes
Deferred Income Taxes
Actual Income Taxes
Tax Policy
Net Income
Equity
Retained Earnings
Dividends
Required Return on Equity

Source: PTm(Steel).

Exhibit 23

BASELINE REVENUE REQUIREMENTS

1981-1990

(millions of 1980 dollars)

SCENARIO 1

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Sales Tax	$ 1,623.2	$ 1,719.1	$ 1,861.6	$1,916.6	$ 2,007.4	$ 2,035.6	$ 2,103.5	$ 2,162.0	$ 2,225.9	$ 2,261.4
Operations and Maintenance Expenses	33,138.6	35,999.0	39,166.8	40,638.0	42,424.8	43,652.2	45,352.2	46,366.4	47,497.2	48,705.1
Capital-Related Charges										
Depreciation	2,030.6	1,992.5	1,962.8	1,966.0	1,939.1	1,905.3	1,923.1	1,957.7	2,018.0	2,073.1
Property Taxes	490.0	468.5	472.1	471.0	450.1	434.3	456.0	462.4	499.7	511.3
Net Interest Expenses	935.3	945.7	942.5	950.7	920.1	909.7	929.1	951.5	962.7	962.8
Income Taxes										
Actual	1,093.9	831.8	940.4	873.7	1,154.6	835.3	802.0	977.4	977.2	765.5
Deferred	80.8	92.0	150.3	204.8	268.8	309.0	260.0	287.5	337.4	428.1
Net Income Requirements	1,495.1	1,252.5	1,386.0	1,276.7	1,400.2	1,191.8	1,159.4	1,293.8	1,549.7	1,257.8
Subtotal	$ 6,125.7	$ 5,582.9	$ 5,862.2	$ 5,722.9	$ 6,132.7	$ 5,585.4	$ 5,529.5	$ 5,929.9	$ 6,344.7	$ 5,997.6
Total	$40,887.6	$43,301.0	$46,890.5	$48,277.5	$50,564.9	$51,273.2	$52,985.2	$54,458.2	$56,067.8	$56,962.1

SCENARIO 2

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Sales Tax	$ 1,626.9	$ 1,699.6	$ 1,766.0	$ 1,879.1	$ 1,915.8	$ 1,870.5	$ 1,815.8	$ 1,947.0	$ 2,124.0	$ 2,098.0
Operations and Maintenance Expenses	33,220.5	35,378.6	37,249.6	40,065.3	40,828.6	40,262.5	39,427.1	42,058.4	45,309.9	45,372.9
Capital-Related Charges										
Depreciation	2,035.1	1,999.0	1,966.3	1,983.2	1,972.7	1,936.7	1,917.9	1,913.5	1,930.3	1,914.5
Property Taxes	492.3	471.5	471.8	485.1	463.5	445.1	438.1	440.2	447.7	432.9
Net Interest Expenses	935.6	943.8	934.5	919.0	901.4	882.1	862.2	846.4	843.5	832.9
Income Taxes										
Actual	1,092.6	801.5	755.7	691.5	822.2	543.4	336.8	640.5	1,104.7	781.4
Deferred	82.5	94.3	164.9	197.3	277.4	338.8	298.6	260.7	272.6	318.5
Net Income Requirements	1,495.1	1,225.4	1,175.6	1,112.1	1,077.7	836.9	641.6	936.2	1,468.9	1,093.9
Subtotal	$ 6,133.1	$ 5,535.4	$ 5,466.8	$ 5,388.3	$ 5,514.9	$ 4,982.9	$ 4,495.2	$ 5,037.4	$ 6,067.6	$ 5,374.2
Total	$40,980.5	$42,811.6	$44,482.3	$47,332.6	$48,259.3	$47,115.9	$45,738.0	$49,042.7	$53,501.5	$52,845.1

Source: Pim(Steel).

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Exhibit 24

ECONOMIC MODULE

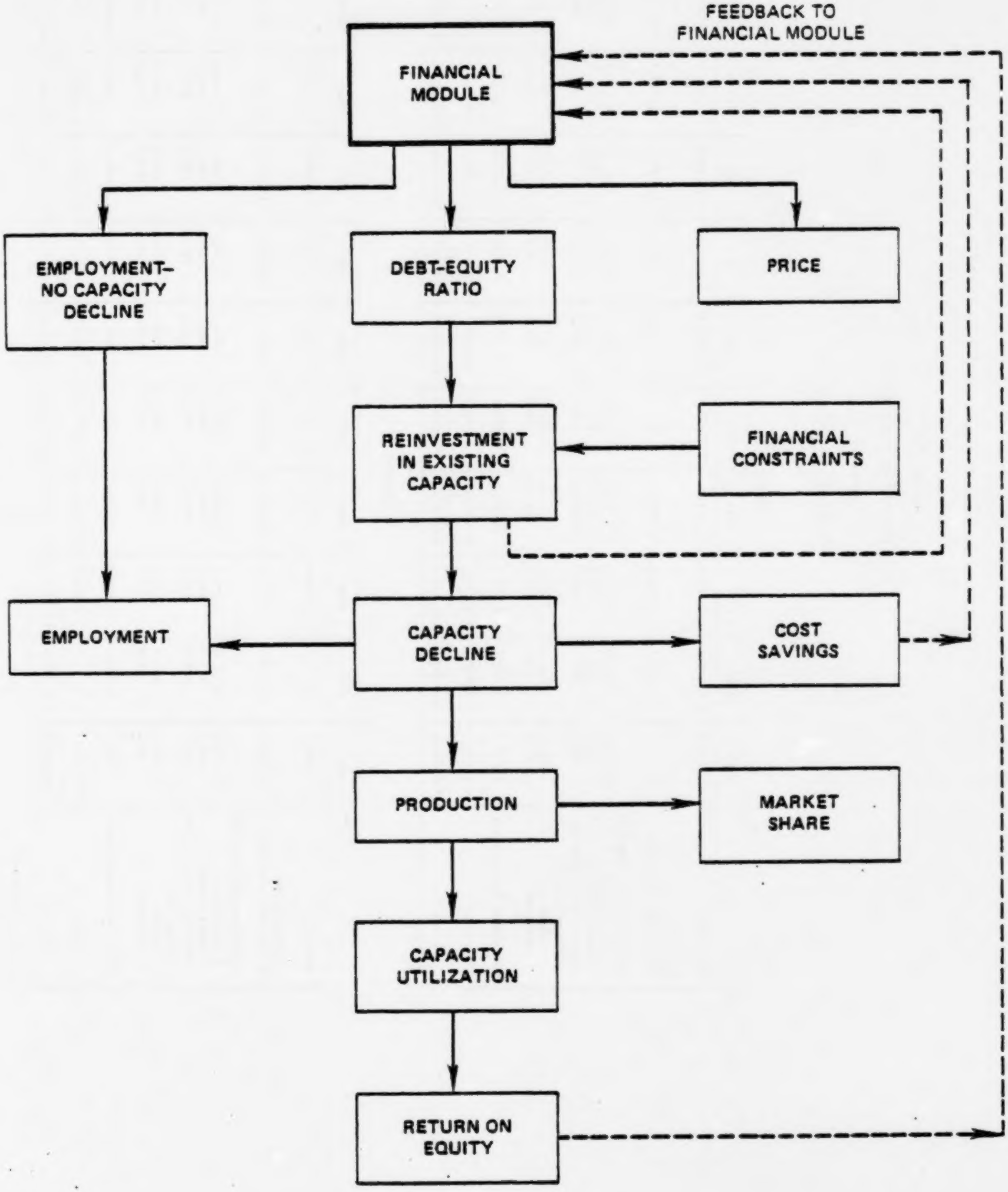
FEEDBACK TO FINANCIAL MODULE
FINANCIAL MODULE
EMPLOYMENT– NO CAPACITY DECLINE
DEBT-EQUITY RATIO
PRICE
REINVESTMENT IN EXISTING CAPACITY
FINANCIAL CONSTRAINTS
EMPLOYMENT
CAPACITY DECLINE
COST SAVINGS
PRODUCTION
MARKET SHARE
CAPACITY UTILIZATION
RETURN ON EQUITY

Exhibit 25

STEEL INDUSTRY EMPLOYMENT WITH NO PRODUCTION DECLINES RELATED TO CAPITAL CONSTRAINTS[1]

(thousands of jobs)

	Scenario 1		Scenario 2	
	1985	1990	1985	1990
Iron and Steel Production[2]	456.01	449.59	449.31	412.99
Miscellaneous Pollution Control Equipment	1.72	1.71	1.59	1.59
Air Pollution Control Equipment				
In Place	4.86	4.60	3.05	2.92
Additions	1.02	1.32	1.65	1.59
Water Pollution Control Equipment				
Pollution Controls In Place But Not Required	0.14	0.12	0.12	0.13
BPT In Place	1.71	1.65	1.64	1.59
BAT In Place	0.02	0.02	0.02	0.02
PSES In Place	0.10	0.10	0.10	0.09
Total Baseline	465.58	459.11	457.48	420.92
Water Pollution Control Additions				
BPT Additions	0.29	0.26	0.27	0.26
BAT Additions	0.06	0.06	0.06	0.06
PSES Additions	0.03	0.03	0.02	0.02
NSPS Additions	0.14	0.50	0.18	0.34
Total Additions	0.52	0.85	0.53	0.68
Total Employment	466.10	459.96	458.01	421.60

[1] Assumes a full 85 percent market share; Exhibits E-4, E-6, E-8, and E-10 in the Executive Summary include the effects of production declines.

[2] Includes process-related direct and indirect employees only.

Exhibit 26

STEEL ENERGY CONSUMPTION WITH NO PRODUCTION DECLINES RELATED TO CAPITAL CONSTRAINTS

1980-1990

(quadrillion Btu)

SCENARIO 1

	1980-1985	1980-1990
Iron and Steel Production		
Coal	8.142	15.002
Other Fuel	4.289	8.082
Electricity	3.130	6.160
Total Consumption	15.560	29.244
Self-Generated Process Gas	3.405	6.135
Net Consumption	12.155	23.109
Air Pollution Control Equipment	0.251	0.514
In-Place Water Pollution Control Equipment	0.059	0.111
Water Pollution Control Additions		
BPT Additions	0.003	0.009
BAT Additions	0.002	0.005
PSES Additions	0.000	0.001
NSPS Additions	0.003	0.011
Total Water Pollution Control Additions	0.008	0.026
Total Net Energy Consumption	12.473	23.760

SCENARIO 2

	1980-1985	1980-1990
Iron and Steel Production		
Coal	7.860	14.155
Other Fuel	4.150	7.631
Electricity	3.042	5.818
Total Consumption	15.051	27.604
Self-Generated Process Gas	3.289	5.792
Net Consumption	11.763	21.812
Air Pollution Control Equipment	0.242	0.478
In-Place Water Pollution Control Equipment	0.059	0.108
Water Pollution Control Additions		
BPT Additions	0.003	0.008
BAT Additions	0.002	0.006
PSES Additions	0.000	0.000
NSPS Additions	0.003	0.010
Total Water Pollution Control Additions	0.008	0.024
Total Net Energy Consumption	12.072	22.422

Source: PTm(Steel).

Appendix

METHODOLOGY AND SUPPORTING EXHIBITS

This Appendix further explains the methodology used in the analysis described in this report and supplements the final report with additional data collected for the analysis.

The majority of the research techniques are incorporated in PTm(Steel), a policy-testing computer model of the iron and steel industry developed by TBS. PTm(Steel) is organized into four major modules, which model the production costs, the pollution control costs, the financial characteristics, and the economic condition of the industry for the period 1976 to 1990. The four major modules are described in the following sections. Specific data collected for each of these modules are included in the exhibits following this Appendix.

PRODUCTION COSTS

The first module in PTm(Steel) calculates production costs. Production cost estimates are based on the production process flow diagram shown in Exhibit 3 of the main report and a production cost model of the iron and steel industry. developed by the AISI. This information--which describes the resource requirements and process yields of 28 production processes--is combined with a linear program to translate the annual demand for finished steel products into the production levels and resource requirements of each production process. Using the production process levels along with AISI's current inventory of steel production facilities, estimates of future facility retirements, and the sustainable utilization rates of production processes, PTm(Steel) allows the capacity additions needed to maintain production levels to be estimated. The physical data described above are used to develop cost estimates for operations and maintenance (O&M), capacity additions, and target levels for capital expenditures on existing capacity.

The data that are used in the production cost module, which were provided by the AISI, include process-specific yields, sustainable utilization rates, capital costs, and reinvestment rates for existing equipment (Exhibit A-1). The resource requirements for steelmaking are shown in Exhibit A-2, the process inventory is detailed in Exhibit A-3, and the plant size breakdown appears in Exhibit A-4. The technological changes in resource requirements expected in the future are shown in Exhibit A-5. These projected changes represent TBS's best estimate of past and current trends. The prices of resources used to develop operating costs are shown in Exhibit A-6.

The methodology used to estimate future shipments of steel products is described in Chapter I of the main report. This methodology uses the mix of finished steel products shown in Exhibit A-7. Because PTm(Steel) models only 87.7 percent of steel production activity, the total steel shipments estimated in Chapter I are reduced accordingly in PTm(Steel) calculations. The cost and financial data presented in this report also reflect the characteristics of this segment of the industry.

POLLUTION CONTROL COSTS

Costs for three categories of pollution controls are estimated in the current analysis: air pollution controls for steel production processes, air pollution controls for coal-fired boilers operated by the steel industry, and water pollution controls. For production processes in each category, annual capital expenditures and O&M expenses are calculated from the costs associated with model pollution control facilities developed by NUS/Rice, from the percentage of steel production facilities in compliance with a regulatory requirement as of a particular date, and from the total number of production facilities in existence as of a particular date. Additional details of this costing methodology are provided in Chapters II and III of the main report.

Facilities in existence, by process, are derived from data in the production cost module. Cost and coverage data for air pollution controls for steel production processes are provided in Exhibit A-8 and Exhibit 10 of the main report, respectively. Cost and coverage data for air pollution controls for boilers are provided in Exhibit A-9. Cost and coverage data for water pollution controls are provided in Exhibits A-10 and A-11. Because the industry subcategorization for water pollution control cost data is different from the 28 AISI production processes, conversions of cost data between the two are necessary. This cost conversion is shown in Exhibit A-12.

FINANCIAL CHARACTERISTICS

The financial modeling of the iron and steel industry is depicted in Exhibit 22 of the main report. The financial module traces the flow of cash, the income statement, and the changes in the balance sheet that result from costs imposed on the industry, including the costs of debt and equity capital. An additional description of the operation of the financial module is provided in Chapter IV of the main report. Exhibit A-13 specifies the major assumptions incorporated into the financial module.

The principal inputs to the financial module used in the current analysis include the capital and operating costs of production and pollution controls, the cost savings associated with the transfer of production from inefficient facilities, and the issues of and returns on common equity capital. In addition, the investment for modernization of existing facilities can be altered as necessary in order to respond to the capital constraints experienced by the industry. These inputs allow the financial module to evaluate the industry's various responses to increased costs in the areas of investment and financing. The sectoral cost escalation factors used to project costs into the future are provided in Exhibit A-14. Exhibit A-15 provides these factors for the higher inflation rate sensitivity analysis.

ECONOMIC CONDITION

The modeling of the economic condition of the steel industry incorporates a number of relationships between the cost and financial structure of the industry and its economics. These include the relationship between capacity utilization and return on equity, the relationship between capital investment and production capacity, the relationship between shifts in production away from inefficient plants and cost savings, and the relationship between reductions in production and declines in employment. More information on the relationships used in the module is provided in Exhibit A-16. The detailed flows of the PTm(Steel) economic module are shown in Exhibit 24 of the main report.

Because of the complex effects that operating costs, return on equity, and capital investment in existing facilities have on the financial characteristics of the steel industry, it is necessary to operate the financial and economic modules repeatedly in a feedback loop, with the output of one module becoming an input to the other. This procedure ensures that constraints calculated by the two modules are consistent.

Exhibit A-1

YIELDS BY PROCESS, MAXIMUM SUSTAINABLE UTILIZATION, CAPITAL COST OF ROUNDOUT CAPACITY ADDITIONS, AND REINVESTMENT RATE FOR MODERNIZATION BY PROCESS

Process	Yield, Tons Out Per Ton In	Maximum Sustainable Utilization (percent)	1978 Dollars per Ton for Roundout Capacity Additions	Percentage of Initial Investment Reinvested Each Year
Raw Materials Preparation				
Ore Yard	1.000	90.0%	$ 11.0	1.0%
Coal Yard	1.000	90.0	11.0	1.0
Scrap Yard	0.980	90.0	7.0	1.0
Sinter Strand	1.000	90.0	31.0	1.0
Coke Ovens	0.699	90.0	172.0	3.0
Ironmaking				
Blast Furnace	N/A	90.0	72.0	1.5
Steelmaking				
Open Hearth Furnace	N/A	90.0	N.A.	1.0
Basic Oxygen Furnace	N/A	90.0	39.0	1.5
Electric Furnace	N/A	90.0	40.0	1.0
Vacuum Degassing	N/A	75.0	N.A.	N.A.
Direct Reduction	N/A	N/A	N/A	N/A
Casting and Forming				
Continuous Casting				
Billets and Blooms	0.952	90.0	80.0	2.0
Slabs	0.943	90.0	84.0	2.0
Conventional Casting				
Ingot Casting	0.980	90.0	7.0	2.0
Breaking—Blooms	0.870	85.0	96.0	3.0
Breaking—Billets	0.862	85.0	48.0	2.7
Breaking—Slabs	0.833	85.0	85.0	3.0
Finishing Mills				
Heavy Structurals	0.833	75.0	480.0	3.0
Hot Rolled Bar and Rod	0.901	75.0	185.0	5.1
Wire Product	0.952	75.0	576.0	5.0
Cold Finisned Bar	0.901	75.0	225.0	4.0
Seamless Pipe and Tube	0.833	75.0	615.0	4.0
Hot Rolled Strip	0.952	85.0	113.0	2.0
Pickling and Oiling	0.943	85.0	47.0	1.7
Welded Pipe and Tube	0.901	75.0	287.0	6.0
Cold Rolled Strip	0.877	75.0	266.0	2.5
Hot Coating—Galvanizing and Terne	0.962	75.0	356.0	2.0
Cold Coating--Tin and Chrome	0.962	75.0	213.0	3.0
Plate	0.794	75.0	189.0	1.0

N/A = Not applicable.
N.A. = Not available.

Source: Arthur D. Little Industry Survey, 1978; AISI Advisory Committee.

Exhibit A-2

RESOURCE REQUIREMENTS FOR STEELMAKING

1976

PHASE I PROCESSES

Page 1 of 2

Phase I Processes	Inputs (tons)							
	Ore	Coal	Scrap	Sinter	Coke	Pellets	Hot Metal[1]	Raw Steel[2]
Ore Yard	1.00	-	-	-	-	-	-	-
Coal Yard	-	1.00	-	-	-	-	-	-
Scrap Yard	-	-	1.02	-	-	-	-	-
Sinter Strand	-	-	-	1.00[a]	-	-	-	-
Coke Oven	-	1.43	-	-	-	-	-	-
Blast Furnace	0.19	-	0.02	0.45	0.54	0.86	-	-
Open Hearth Furnace	-	-	0.50	-	-	-	0.63	-
Basic Oxygen Furnace	-	-	0.34	-	-	-	0.79	-
Electric Furnace	-	-	1.07	-	-	-	-	-
Ingot Casting	-	-	-	-	-	-	-	1.02
Continuous Casting--Slabs	-	-	-	-	-	-	-	1.06
Continuous Casting--Billets and Blooms	-	-	-	-	-	-	-	1.05

Phase I Processes	Labor (man-hours/ton)			Overhead and Selling, General and Administrative (fraction of labor costs)	Power (kWh/ton)	Fuel (MMBtu/ton)	Water (thousand gallons/ton)	Other Raw Material Maintenance and Miscellaneous Costs[3] ($/ton)	Scrap Out (tons)
	Small	Medium	Large						
Ore Yard	0.10	0.07	0.06	0.53	3.50	-	0.01	0.64	-
Coal Yard	0.07	0.06	0.05	0.69	4.35	0.03	0.05	1.00	-
Scrap Yard	0.35	0.19	0.16	1.13	4.65	-	0.04	1.50	-
Sinter Strand	0.31	0.30	0.28	0.75	45.36	1.31	0.38	2.91	-
Coke Oven	0.56	0.51	0.43	0.75	23.80	(7.70)	5.55	2.41	-
Blast Furnace	0.39	0.33	0.27	0.53	24.50	(4.57)	10.95	7.79	0.01
Open Hearth Furnace	1.30	0.95	0.92	2.04	21.74	3.47	6.10	10.41	0.02
Basic Oxygen Furnace	0.43	0.45	0.46	1.77	30.44	0.22	2.31	14.68	0.02
Electric Furnace	3.26	0.81	0.67	2.49[b]	409.48	0.24	3.50	17.39	0.01
Ingot Casting	0.19	0.06	0.02	1.99	-	-	-	5.07	0.02
Continuous Casting--Slabs	1.02	-	1.01	0.64	49.00	0.79	2.00	6.61	0.04
Continuous Casting--Billets and Blooms	0.65	0.48	0.34	1.94	49.00	0.79	2.00	3.39	0.03

(continued)

Exhibit A-2 (continued)

PHASE II PROCESSES

Page 2 of 2

Phase II Processes	Inputs (tons)							
	Ingots	Blooms	Billets	Slabs	Bar Mill	Hot Strip Mill	Pickled Steel	Cold Finished Steel
Primary Breakdown--Blooms	1.15	-	-	-	-	-	-	-
Primary Breakdown--Billets	0.50	0.66	-	-	-	-	-	-
Primary Breakdown--Slabs	1.20	-	-	-	-	-	-	-
Heavy Structurals	-	1.20	-	-	-	-	-	-
Hot Rolled Bar & Rod	-	-	1.11	-	-	-	-	-
Wire Product	-	-	-	-	1.05	-	-	-
Cold Finished Bar	-	-	-	-	1.09	-	-	-
Seamless Pipe & Tube	-	-	1.20	-	-	-	-	-
Hot Rolled Strip	-	-	-	1.05	-	-	-	-
Pickling & Oiling	-	-	-	-	-	1.06	-	-
Welded Pipe & Tube	-	-	-	-	-	-	1.11	-
Cold Reduction	-	-	-	-	-	-	1.14	-
Hot Coating--Galvanizing & Terne	-	-	-	-	-	-	-	1.04
Cold Coating--Tin	-	-	-	-	-	-	-	1.04
Plate Mill	-	-	-	1.26	-	-	-	-

Phase II Processes	Labor (man-hours/ton)			Overhead and Selling, General and Administrative (fraction of labor costs)	Power (kWh/ton)	Fuel (MMBtu/ton)	Water (thousand gallons/ton)	Other Raw Materials Maintenance and Miscellaneous Costs[3] ($/ton)	Scrap Out (tons)
	Small	Medium	Large						
Primary Breakdown--Blooms	1.22	0.69	0.38	1.07	42.00	2.37	1.40	5.79	0.13
Primary Breakdown--Billets	5.45	0.72	0.42	1.07	42.00	2.59	1.40	8.29	0.13
Primary Breakdown--Slabs	1.23	0.37	0.25	1.94	42.00	1.51	1.40	4.34	0.19
Heavy Structurals	0.68	0.60	0.33	0.65	168.00	1.76	4.00	6.12	0.20
Hot Rolled Bar & Rod	6.34	1.65	0.82	0.86	95.20	2.90	9.20	8.66	0.09
Wire Product	5.83	3.69	3.31	1.13	420.00	-	-	11.76	-
Cold Finished Bar	-	-	6.58	1.79	140.00	3.20	-	19.08	-
Seamless Pipe & Tube	10.35	2.55	1.50	1.03	224.00	6.75	0.66	2.25	0.16
Hot Rolled Strip	1.07	0.52	0.40	1.83	116.20	2.80	5.40	8.06	0.04
Pickling & Oiling	0.34	0.31	0.30	1.15	12.60	-	0.15	2.62	0.04
Welded Pipe & Tube	6.30	4.10	1.96	0.59	98.00	6.00	5.00	15.02	0.10
Cold Reduction	9.00	1.80	0.96	0.91	168.00	1.62	0.26	8.52	0.12
Hot Coating- Galvanizing & Terne	1.94	1.24	1.01	1.17	67.20	1.85	1.20	43.94	0.02
Cold Coating--Tin	0.95	0.78	0.69	1.72	148.40	2.20	4.70	83.04	0.02
Plate Mill	3.29	2.62	3.04	0.73	134.40	6.60	9.30	17.08	0.23

[1] Hot metal is defined as the pig iron from the blast furnace.

[2] Raw steel is defined as the sum of molten steel tonnages from each of the steel furnace types, including open hearth, basic oxygen furnace, and electric furnace.

[3] Includes cost of fuel and water.

[a] Amounts of ore, sinter, and pellets combined to form sinter in a ratio of one ton of raw material to one ton of sinter.

[b] Small furnaces only, factors for medium and large furnaces are 2.08 and 2.20, respectively.

Source: Arthur D. Little Industry Survey, 1978.

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Exhibit A-3

1976 PROCESS INVENTORY--NUMBER OF UNITS

Process	Small			Medium			Large		
	Pre-1949	1950-1966	1967-1976	Pre-1949	1950-1966	1967-1976	Pre-1949	1950-1966	1967-1976
Raw Materials Preparation									
Ore Yard	11	2	0	8	5	0	12	2	0
Coal Yard	6	4	0	4	5	0	8	2	0
Scrap Yard	7	13	6	21	12	3	4	7	1
Sinter Strand	2	7	2	2	9	3	1	4	1
Coke Ovens	23	32	7	9	16	5	1	11	13
Ironmaking									
Blast Furnace	42	4	2	41	10	1	13	23	5
Steelmaking									
Open Hearth Furnace	4	0	0	1	5	0	3	3	0
Basic Oxygen Furnace	0	7	0	0	6	5	0	3	7
Electric Furnace	4	10	5	6	6	7	0	6	5
Casting and Forming									
Continuous Casting									
Billets and Blooms	0	0	3	0	0	4	0	0	6
Slabs	0	0	4	0	0	0	0	0	6
Conventional Casting									
Ingot Casting	11	9	3	3	12	5	5	12	4
Breaking--Blooms	5	7	0	5	5	0	3	5	0
Breaking--Billets	4	5	3	10	5	0	3	5	0
Breaking--Slabs	6	5	1	8	5	0	4	7	2
Finishing Mills									
Heavy Structurals	4	1	0	3	2	0	5	0	0
Hot Rolled Bar and Rod	4	5	0	12	4	1	13	3	2
Wire Product	4	1	1	5	2	0	3	1	1
Cold Finished Bar	0	0	0	5	5	0	2	0	2
Seamless Pipe and Tube	3	0	2	3	1	0	3	1	0
Hot Rolled Strip	4	6	1	5	5	3	2	6	1
Pickling and Oiling	6	7	2	3	9	2	2	3	3
Welded Pipe and Tube	3	2	0	0	5	0	0	5	0
Cold Rolled Strip	6	4	2	7	7	1	2	6	2
Hot Coating--Galvanizing and Terne	1	6	2	2	4	2	2	6	0
Cold Coating--Tin and Chrome	2	3	0	1	3	0	1	3	1
Plate	2	2	1	1	2	1	2	2	1

Source: Arthur D. Little Industry Survey, 1978.

A-9

Exhibit A-4

PLANT SIZE BREAKDOWN BY PROCESS

1976

(capacity in millions of tons)

Process	Small			Medium			Large			Total			Grand Total
	Pre-1949	1950-1966	1967-1976	Pre-1949	1950-1966	1967-1976	Pre-1949	1950-1966	1967-1976	Pre-1949	1950-1966	1967-1976	
Raw Materials Preparation													
Ore Yard	20.38	3.70	-	31.54	19.72	-	83.31	13.19	-	135.23	36.61	-	171.84
Coal Yard	6.77	4.52	-	10.20	12.76	-	31.97	22.00	-	48.94	39.28	-	88.22
Scrap Yard	1.40	2.61	1.20	22.39	12.79	3.20	7.17	20.72	2.13	30.96	36.12	6.53	73.61
Sinter Strand	1.07	3.74	1.07	2.92	13.15	4.38	3.31	13.24	3.31	7.30	30.13	8.76	46.19
Coke Ovens	6.40	8.90	1.95	4.28	7.62	2.38	1.95	12.54	14.15	12.63	29.06	18.48	60.17
Ironmaking													
Blast Furnace	17.38	1.65	0.83	31.71	7.73	0.78	14.51	22.71	9.21	63.60	32.09	10.82	106.51
Steelmaking													
Open Hearth Furnace	1.40	-	-	1.41	7.04	-	8.20	9.91	-	11.01	16.95	-	27.96
Basic Oxygen Furnace	-	9.39	-	-	16.03	13.53	-	19.03	33.77	-	39.45	47.30	86.75
Electric Furnace	0.34	1.03	0.58	2.95	2.95	3.45	-	5.62	7.41	3.29	9.60	11.44	24.33
Casting and Forming													
Continuous Casting													
Billets and Blooms	-	-	0.90	-	-	1.16	-	-	3.69	-	-	5.75	5.75
Slabs	-	-	1.45	-	-	-	-	-	9.80	-	-	11.25	11.25
Conventional Casting													
Ingot Casting	2.86	2.34	0.79	4.77	19.09	7.95	21.67	45.52	16.94	29.30	66.95	25.68	121.93
Breaking--Blooms	1.59	2.23	-	2.65	4.43	-	6.05	10.07	-	10.29	16.73	-	27.02
Breaking--Billets	0.47	0.41	0.11	6.83	3.41	-	10.03	4.72	-	17.33	8.54	0.11	25.98
Breaking--Slabs	2.59	2.15	0.43	15.29	9.56	-	13.03	26.27	5.60	30.91	37.98	6.03	74.92
Finishing Mills													
Heavy Structurals	1.67	0.42	-	2.39	1.36	-	9.13	-	-	13.19	1.78	-	14.97
Hot Rolled Bar and Rod	0.52	0.43	-	4.46	1.49	0.37	14.13	3.29	2.07	19.11	5.21	2.44	26.76
Wire Product	0.16	0.04	0.04	0.90	0.36	-	1.65	0.42	0.30	2.71	0.82	0.34	3.87
Cold Finished Bar	-	-	-	0.43	0.43	-	0.21	-	0.34	0.64	0.43	0.34	1.41
Seamless Pipe and Tube	0.11	-	0.07	0.57	0.19	-	2.09	0.66	-	2.77	0.85	0.07	3.69
Hot Rolled Strip	2.10	3.15	0.52	11.63	11.63	6.90	9.07	22.17	5.90	22.80	36.95	13.40	73.15
Pickling and Oiling	2.71	3.16	0.91	4.95	14.84	3.29	7.85	12.89	8.69	15.51	30.89	12.89	59.29
Welded Pipe and Tube	0.27	0.18	-	-	1.29	-	-	3.33	-	0.27	4.80	-	5.07
Cold Rolled Strip	0.69	0.46	0.23	7.18	7.18	1.03	7.55	16.14	7.62	15.42	23.78	8.88	48.08
Hot Coating--Galvanizing and Terne	0.13	0.58	0.16	0.57	1.14	0.56	1.45	3.42	-	2.15	5.14	0.72	8.01
Cold Coating--Tin and Chrome	0.70	1.04	-	0.64	1.07	-	1.24	3.25	0.87	2.58	6.16	0.87	9.61
Plate	0.51	0.51	0.25	0.77	1.55	0.78	3.56	3.55	1.77	4.84	5.61	2.80	13.25

Source: Arthur D. Little Industrial Survey, 1978.

Exhibit A-5

TECHNOLOGY CHANGES

1976-1990

SCENARIO 1

Page 1 of 2

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Molten Steel Produced by Furnace Type (percent)															
Open Hearth Furnace	18.3	16.0	15.6	14.0	11.7	11.0	10.5	10.0	10.0	10.0	9.5	8.7	8.7	8.7	8.7
Basic Oxygen Furnace	62.5	61.8	60.9	61.1	60.4	60.2	59.5	62.0	59.0	58.0	57.0	55.5	57.0	58.0	58.4
Electric Furnace	19.2	22.2	23.5	24.9	27.9	28.8	30.0	28.0	31.0	32.0	33.5	35.8	34.3	33.3	32.9
Billets and Blooms by Casting Method (percent)															
Continuous Casting	10.6	12.5	15.2	16.9	20.3	15.7	15.5	15.6	15.1	16.2	22.3	28.6	37.0	49.7	55.5
Conventional Casting	89.4	87.5	84.8	83.1	79.7	84.3	84.5	84.4	84.9	83.8	77.7	71.4	63.0	50.3	44.5
Slabs by Casting Method (percent)															
Continuous Casting	10.6	12.5	15.2	16.9	20.3	25.5	27.4	29.3	34.3	37.1	37.8	39.5	37.0	36.6	37.5
Conventional Casting	89.4	87.5	84.8	83.1	79.7	74.5	72.6	70.7	65.7	62.9	62.2	60.5	63.0	63.4	62.5
Molten Steel Vacuum Degassed (percent)	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
Pickled Hot Strip (percent of total hot strip sold)	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0
Electricity Generated (percent of electricity used)	18.4	17.7	16.2	15.5	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7
Coke Rate (tons per ton of pig iron)	.540	.540	.535	.530	.528	.527	.526	.524	.522	.520	.517	.514	.511	.507	.503
Fuel Generated in Blast Furnaces (million Btu per ton)	4.570	4.570	4.494	4.416	4.337	4.255	4.172	4.086	3.998	3.908	3.816	3.721	3.624	3.525	3.423

(continued)

Exhibit A-5 (continued)

SCENARIO 2

Page 2 of 2

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Molten Steel Produced by Furnace Type (percent)															
Open Hearth Furnace	18.3	16.0	15.6	14.0	11.7	11.0	10.5	10.0	10.0	10.0	9.5	8.7	8.7	8.7	8.7
Basic Oxygen Furnace	62.5	61.8	60.9	61.1	60.4	60.2	59.5	62.0	59.0	58.0	57.0	55.5	57.0	58.0	58.4
Electric Furnace	19.2	22.2	23.5	24.9	27.9	28.8	30.0	28.0	31.0	32.0	33.5	35.8	34.3	33.3	32.9
Billets and Blooms by Casting Method (percent)															
Continuous Casting	10.6	12.5	15.2	16.9	20.3	15.7	15.5	16.2	16.6	16.9	22.3	28.6	37.0	49.7	55.5
Conventional Casting	89.4	87.5	84.8	83.1	79.7	84.3	84.5	83.8	83.4	83.1	77.7	71.4	63.0	50.3	44.5
Slabs by Casting Method (percent)															
Continuous Casting	10.6	12.5	15.2	16.9	20.3	25.5	27.4	29.3	37.7	38.6	37.8	39.5	37.0	36.6	37.5
Conventional Casting	89.4	87.5	84.8	83.1	79.7	74.5	72.6	70.7	62.3	61.4	62.2	60.5	63.0	63.4	62.5
Molten Steel Vacuum Degassed (percent)	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
Pickled Hot Strip (percent total hot strip sold)	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0
Electricity Generated (percent of electricity used)	18.4	17.7	16.2	15.5	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7
Coke Rate (tons per tons of pig iron)	.540	.540	.535	.530	.528	.527	.526	.524	.522	.520	.517	.514	.511	.507	.503
Fuel Generated in Blast Furnaces (million Btu per ton)	4.570	4.570	4.494	4.416	4.337	4.255	4.172	4.086	3.998	3.908	3.816	3.721	3.624	3.525	3.423

Source: TBS analysis.

Exhibit A-6

1976 COSTS OF RESOURCES

Ore (per ton)	$24.98
Coal (per ton)	47.65
Scrap (per ton)	69.46
Labor (per hour)	11.74
Electricity (per kWh)	0.0207
Fuel (per MMBtu)	1.49
Water (per thousand gallons)	0.12

Source: Standard & Poor's Steel-Coal Basic Analysis; U.S. Bureau of Mines Mineral Commodity Summary; Peter Marcus, *World Steel Dynamics*; *Iron Age*; AISI *Annual Statistical Reports*; *EEI Statistical Yearbook*; D.O.E. *Monthly Energy Review*; Arthur D. Little Industry Survey, 1978.

Exhibit A-7

PROJECTIONS OF STEEL SHIPMENTS BY PRODUCT

1976-1990

(percent of total shipments)

Product	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Direct Shipments of Ingots, Blooms, Billets, and Slabs	2.8	2.4	2.5	2.6	3.2	3.0	2.8	2.8	2.8	2.6	2.8	2.8	2.8	2.8	2.8
Heavy Structurals and Rails	7.0	6.9	6.8	7.6	8.3	8.6	8.7	9.0	9.1	8.9	9.4	9.3	8.8	8.7	8.9
Nails and Wire Products	2.7	2.6	2.6	2.4	2.1	2.1	2.0	1.9	1.8	1.9	2.1	1.8	1.4	1.3	1.5
Bars and Light Structurals	16.2	17.0	17.8	18.3	17.1	17.5	17.5	17.3	17.6	17.8	17.8	17.8	17.8	18.0	18.2
Cold Finished Bars	1.8	1.9	2.1	2.2	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	2.0	2.0
Seamless Pipe	3.0	4.1	4.3	4.1	5.2	5.4	5.2	5.6	5.6	5.8	5.7	5.5	5.4	5.4	5.4
Welded Pipe	4.0	4.1	4.3	4.1	5.7	4.9	4.5	4.7	4.6	4.5	4.4	4.3	4.2	4.2	4.3
Hot Rolled Sheet and Strip	18.2	17.2	16.9	17.0	15.3	15.8	15.8	15.4	15.4	15.1	15.0	15.5	15.8	15.5	15.5
Galvanized Products	5.8	6.2	6.6	6.3	6.2	6.3	6.3	6.3	6.3	6.3	5.8	6.0	6.2	6.2	6.2
Tin and Other Plated Products	7.4	7.3	6.6	6.7	7.1	6.8	6.8	6.8	6.6	6.5	6.3	6.4	6.8	6.8	6.8
Cold Rolled Sheet and Strip	23.1	22.0	20.7	19.6	18.3	18.7	18.7	18.2	18.3	18.5	18.3	18.5	18.6	18.6	18.6
Plate	8.0	8.3	8.8	9.0	9.6	9.0	9.8	10.1	10.0	10.2	10.5	10.2	10.3	10.5	10.0

Source: 1976-1978: AISI Annual Statistical Reports.
1979-1990: projections based on 1960-1975 product mix.

Exhibit A-8

MODEL PLANT COST DATA FOR
AIR POLLUTION CONTROLS

Page 1 of 6

```
 10   C*****************************************************************
 20   C                          PEDCO DATA FILE
 30   C*****************************************************************
 40   C  SOURCE:  SPDCAIR                              BINARY:  PDCAIRB
 50   C
 60   C    THE FOURTEEN COLUMNS ARE AS FOLLOWS:
 70   C        1--PROCESS NUMBER
 80   C        2--EMISSION INDICATOR (1=STACK; 2=FUGITIVE; 4=NSPS)
 90   C        3--UNITS PER PLANT
100   C        4--CAPITAL COSTS RETROFIT   A
110   C        5--                         B
120   C        6--CAPITAL COSTS NEW        A
130   C        7--                         B
140   C        8--KWH CONSUMED             A
150   C        9--                         B
160   C       10--LABOR HOURS CONSUMED     A
170   C       11--                         B
180   C       12--MISCELLANEOUS COSTS      A
190   C       13--                         B
200   C       14--PERCENT TREATED
210   C
220   C    THE ONE HUNDRED THIRTY-FOUR ROWS ARE AS FOLLOWS:
230   C
240   C        1--FILE PARAMETERS -NUMBER OF:  ROWS TO FOLLOW, COLUMNS,
250   C           PROCESSES, TECHNOLOGIES, STACK EQTNS., FUGITIVE EQTNS.
260   C           AND NSPS EQTNS.
270   C        2--SINTER WINDBOX R            69--BOF HOT METAL TR R
280   C        3--               B            70--                 B
290   C        4--               L            71--                 L
300   C        5--COKE CHARGING R             72--BOF CHARGING, TAPPING R
310   C        6--              B             73--                      B
320   C        7--              L             74--                      L
330   C        8--COKE OVEN PUSHING R         75--BOF SLAG POURING R
340   C        9--                  B         76--                 B
350   C       10--                  L         77--                 L
360   C       11--COKE QUENCHING R            78--BOF SLAG PROC  R
370   C       12--               B            79--               B
380   C       13--               L            80--               L
390   C       14--COKE OVEN STACK R           81--EAF SLAG POURING R
400   C       15--                B           82--                 B
410   C       16--                L           83--                 L
420   C       17--COKE OVEN GAS R             84--EAF SLAG PROC R
430   C       18--              B             85--              B
440   C       19--              L             86--              L
450   C       20--BF CAST HOUSE EM R          87--CONT CASTING BHS R
460   C       21--                 B          88--                 B
470   C       22--                 L          89--                 L
480   C       23--OH REFINING R               90--CONT CASTING R
490   C       24--            B               91--     SLABS   B
500   C       25--            L               92--             L
510   C       26--BOF REFINING R              93--SCARFING BLOOMS R
520   C       27--             B              94--                B
530   C       28--             L              95--                L
540   C       29--EAF REFINING EM R           96--SCARFING BHS R
550   C       30--                B           97--             B
560   C       31--                L           98--             L
570   C       32--ORE YARD R                  99--SCARFING SLABS R
580   C       33--         B                 100--               B
590   C       34--         L                 101--               L
600   C       35--COAL YARD R                102--SINTER WINDBOX N
610   C       36--          B                103--COKE CHARGING N
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(continued)

Exhibit A-8 (continued)

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620   C         37--             L            104--COKE OVEN PUSHING N
630   C         38--SINTER DISCHARGE R        105--COKE QUENCHING N
640   C         39--                 B        106--COKE OVEN STACK N
650   C         40--                 L        107--COKE OVEN GAS N
660   C         41--SINTER FUG BLDG R         108--BF CAST HOUSE EM N
670   C         42--                B         109--OH REFINING N
680   C         43--                L         110--BOF REFINING N
690   C         44--COKE OVEN DOORS R         111--EAF REFINING EM N
700   C         45--                B         112--ORE YARD N
710   C         46--                B^        113--COAL YARD N
720   C         47--                L         114--SINTER DISCHARGE N
730   C         48--COKE OVEN TOPSIDE R       115--SINTER FUG BLDG N
740   C         49--                  B       116--COKE OVEN DOORS N
750   C         50--                  L       117--COKE OVEN TOPSIDE N
760   C         51--COKE HANDLING (SCR) R     118--COKE HANDLING (SCR) N
770   C         52--                    B     119--BF SLAG POURING N
780   C         53--                    L     120--BF SLAG PROC N
790   C         54--BF SLAG POURING R         121--OH HOT METAL TR N
800   C         55--                B         122--OH FUG N
810   C         56--                L         123--OH SLAG PROC N
820   C         57--BF SLAG PROC R            124--BOF HOT METAL TR N
830   C         58--             B            125--BOF CHARGING,TAPPING N
840   C         59--             L            126--BOF SLAG POURING N
850   C         60--OH HOT METAL TR R         127--BOF SLAG PROC N
860   C         61--                B         128--EAF SLAG POURING N
870   C         62--                L         129--EAF SLAG PROC N
880   C         63--OH FUG R                  130--CONT CAST BLT N
890   C         64--       B                  131--CONT CAST SLABS N
900   C         65--       L                  132--SCARFING BLOOMS N
910   C         66--OH SLAG PROC R            133--SCARFING BHS N
920   C         67--             B            134--SCARFING SLABS N
930   C         68--             L
940   C
950   C
960   C
970   C                                                  BTD 7/09/80
980   C<<*****************************>)**********************************
990   C
1000     1,   133  14  133 0 30 70 0 33 6*0
1010     2,   4.   1.   1.00      2174.79    .5153      2211.99   .5061>
1020                   4.11    .8273      30.39    .6007       13.67    .6557    0
1030     3,   4.   1.   1.00      3944.04    .4784      4009.18   .4693>
1040                   6.17    .8271      38.02    .5864       15.57    .6494    0
1050     4,   4.   1.   1.00      2215.35    .5554      2117.36   .5510>
1060                   1.21    .8495  .  2530.05    .3479       84.82    .6083 1.00
1070     5,   5.   1.   1.00    262207.85    .0210    256761.63   .0209>
1080                      0          0   84099.99        0      351.87    .4291  .22
1090     6,   5.   1.   1.00      8478.82    .3986      7707.92   .3986>
1100                      0          0  100199.96        0      671.18    .3874  .78
1110     7,   5.   1.   1.00      8478.82    .3986      7707.92   .3986>
1120                      0          0  100199.96        0      671.18    .3874    0
1130     8,   5.   1.   1.00    385341.17    .1938    350319.68   .1938>
1140                      0          0  129299.91        0      337.92    .5244    0
1150     9,   5.   1.   1.00    385341.17    .1938    350319.68   .1938>
1160                      0          0  129299.91        0      337.92    .5244    0
1170    10,   5.   1.   1.00    385341.17    .1938    350319.68   .1938>
1180                      0          0  129299.91        0      337.92    .5244 1.00
1190    11,   5.   1.   3.90       204.98    .7631       185.22   .7632>
1200                    .04    .9999     113.51    .6002        3.05    .9765    0
1210    12,   5.   1.   3.90       204.98    .7631       185.22   .7632>
1220                    .04    .9999     113.51    .6002        3.05    .9765    0
```

(continued)

Exhibit A-8 (continued)

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1230      13;  5.  1.   3.90      265.14    .7587      235.84   .7590>
1240                  .04    .9999      109.93    .6058        3.36   .9712  1.00
1250      14;  5.  1.   1.00     1783.39    .5186     1553.47   .5142>
1260                  .08    .9535           0  1.3193      348.52   .3755  1.00
1270      15;  5.  1.   1.00     1783.39    .5186     1553.47   .5142>
1280                  .08    .9535           0  1.3193      348.52   .3755     0
1290      16;  5.  1.   1.00     3605.98    .4818     3219.14   .4760>
1300                  .09    .9567         .01  1.2364      587.75   .3432     0
1310      17;  5.  1.   3.90    10914.90    .4806     8423.11   .4804>
1320                  .02    .9967   304999.99       0       37.01   .6880  1.00
1330      18;  5.  1.   3.90    11296.37    .4807     8716.50   .4805>
1340                  .02    .9967   304999.99       0       19.68    7494     0
1350      19;  5.  1.   3.90    11678.23    .4808     9009.89   .4806>
1360                  .02    .9967   304999.99       0       13.36   .7903     0
1370      20;  7.  1.   1.00   113443.85    .2403    93474.38   .2405>
1380               596.85    .3611    30279.80    .1219     4564.11   .2067   .67
1390      21;  7.  1.   1.00   237250.90    .2189   230472.64   .2053>
1400              9668.84    .1980   400944.37    .0419    87196.55   .0784     0
1410      22;  7.  1.   1.00     3023.94    .5409     2774.12   .5311>
1420                16.90    .6868      739.39    .4223       34.92   .5705   .33
1430      23;  8.  1.   1.00     7057.85    .5086     5537.89   .5096>
1440                  .99    .8815    34562.76    .1872      308.18   .4932     0
1450      24;  8.  1.   1.00     7057.85    .5086     5537.89   .5096>
1460                  .99    .8815    34562.76    .1872      308.18   .4932     0
1470      25;  8.  1.   1.00     7057.85    .5086     5537.89   .5096>
1480                  .99    .8815    34562.76    .1872      308.18   .4932  1.00
1490      26;  9.  1.   1.00     2897.68    .5461     2576.99   .5469>
1500                  .19    .9878    25978.49    .1967        5.37   .8041   .81
1510      27;  9.  1.   1.00     2747.91    .5562      378.13   .6502>
1520                  .13    .9965     3389.02    .3092     1056.11   .3862     0
1530      28;  9.  1.   1.00     2747.91    .5562      378.13   .6502>
1540                  .13    .9965     3389.02    .3092     1056.11   .3862   .19
1550      29;  10  1.   1.00       58.37    .8085       57.20   .8000>
1560                  .41    .9492       60.80    .5928        4.53   .8609     0
1570      30;  10  1.   1.00     1221.83    .6474     1109.18   .6467>
1580                 2.16    .9378     2828.56    .3441       16.36   .7791   .80
1590      31;  10  1.   1.00    12019.03    .5064    10684.84   .5071>
1600                68.33    .7324    31793.78    .1762      144.07   .6258   .21
1610      32;  1.  2.   1.00   235099.81        0   209500.11       0>
1620                    0   1.0279    37200.04       0         .16   .9598  1.00
1630      33;  1.  2.   1.00   519300.64        0   432999.98       0>
1640                    0    .9464    55800.00       0         .29   .9481     0
1650      34;  1.  2.   1.00       32.13    .7674       25.54   .7749>
1660                    0   1.0000        1.65    .8467        .49   .9864     0
1670      35;  2.  2.   1.00   235099.81        0   209500.11       0>
1680                    0   1.1041    37200.04       0         .21   .9194  1.00
1690      36;  2.  2.     1.   429699.91        0   369000.03       0>
1700                    0    .9962    43600.05       0         .36   .9101     0
1710      37;  2.  2.   1.00       48.62    .7638       38.30   .7731>
1720                    0   1.0222        2.66    .8447        .43   .9689     0
1730      38;  4.  2.   1.00     9893.58    .3595     9410.72   .3559>
1740                95.15    .4642     7844.02    .1892       22.41   .5794     0
1750      39;  4.  2.   1,00    12309.22    .3579    11553.25   .3549>
1760               126.89    .4500     8669.38    .1911       30.51   .5676     0
1770      40;  4.  2.   1.00    12309.22    .3579    11553.25   .3549>
1780               126.89    .4500     8669.38    .1911       30.51   .5676  1.00
1790      41;  4.  2.   1.00           0        0           0       0>
1800                    0        0           0       0           0       0     0
1810      42;  4.  2.   1.00    16258.40    .2079    16647.22   .1998>
1820               144.62    .2723    11428.83    .0909     1195.60   .2103     0
1830      43;  4.  2.   1.00    16258.40    .2079    16647.22   .1998>
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(continued)

Exhibit A-8 (continued)

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1840                  144.62    .2723   11428.83    .0909     1195.60    .2103 1.00
1850       44;   5.   2.   1.00             0         0           0         0>
1860                       0          0  283300.13         0  121300.02          0     0
1870       45;   5.   2.   1.00             0         0           0         0>
1880                       0          0  283300.13         0  121300.02          0   .65
1890       46;   5.   2.   1.00    47116.68     .3088    47111.02   .3088>
1900                       0          0  283300.13         0  121300.02          0   .35
1910       47;   5.   2.   1.00   419999.79         0  349999.83          0>
1920                       0          0  436899.81         0   79299.93          0     0
1930       48;   5.   2.   1.00             0         0           0         0>
1940                       0          0  141600.03         0   54100.03          0     0
1950       49;   5.   2.   1.00             0         0           0         0>
1960                       0          0  141600.03         0   54100.03          0     0
1970       50;   5.   2.   1.00             0         0           0         0>
1980                       0          0  141600.03         0   54100.03          0  1.00
1990       51;   5.   2.   3.90      1003.39     .4578       934.58   .4556>
2000                  81.00    .3998       32.47    .5358      173.27    .3580   .55
2010       52;   5.   2.   3.90      1003.39     .4578       934.58   .4556>
2020                  81.00    .3998       32.47    .5358      173.27    .3580     0
2030       53;   5.   2.   3.90      1003.39     .4578       934.58   .4556>
2040                  81.00    .3998       32.47    .5358      173.27    .3580     0
2050       54;   7.   2.   1.00             0         0           0         0>
2060                       0       0           0         0          0          0     0
2070       55;   7.   2.   1.00       670.25     .5903       626.85   .5877>
2080                    .20  1.0053        27.63    .5980        5.68    .7120   .63
2090       56;   7.   2.   1.00       670.25     .5903       626.85   .5877>
2100                    .20  1.0053        27.63    .5980        5.68    .7120     0
2110       57;   7.   2.   3.49     24999.99         0    24999.99         0>
2120                       0       0     4799.99         0    5200.00          0   .13
2130       58;   7.   2.   3.49     10281.86     .2272      9680.21   .2244>
2140                  12.15    .3894    22016.49    .0386     3711.06    .1184   .50
2150       59;   7.   2.   3.49     10281.86     .2272      9680.21   .2244>
2160                  12.15    .3894    22016.49    .0386     3711.06    .1184     0
2170       60;   8.   2.   1.00     38176.56     .2449     34441.13   .2415>
2180                 220.14    .3370    22105.23    .1039     1793.59    .2108  1.00
2190       61;   8.   2.   1.00     38176.56     .2449     34441.13   .2415>
2200                 220.14    .3370    22105.23    .1039     1793.59    .2108     0
2210       62;   8.   2.   1.00     38176.56     .2449     34441.13   .2415>
2220                 220.14    .3370    22105.23    .1039     1793.59    .2108     0
2230       63;   8.   2.   1.00             0         0           0         0>
2240                       0       0           0         0          0          0   .01
2250       64;   8.   2.   1.00             0         0           0         0>
2260                       0       0           0         0          0          0     0
2270       65;   8.   2.   1.00       261.24     .7606       239.50   .7581>
2280                    .64  1.0330    41078.75    .1499     1085.66    .3762   .99
2290       66;   8.   2.   1.00     24999.99         0    24999.99         0>
2300                       0       0     4799.99         0    5200.00          0   .05
2310       67;   8.   2.   1.00     24999.99         0    24999.99         0>
2320                       0       0     4799.99         0    5200.00          0   .81
2330       68;   8.   2.   1.00     24999.99         0    24999.99         0>
2340                       0       0     4799.99         0    5200.00          0     0
2350       69;   9.   2.   1.00     33749.15     .2474     31560.49   .2457>
2360                 172.28    .3505    22467.71    .1013     1110.78    .2428  1.00
2370       70;   9.   2.   1.00     33749.15     .2474     31560.49   .2457>
2380                 172.28    .3505    22467.71    .1013     1110.78    .2428     0
2390       71;   9.   2.   1.00     33749.15     .2474     31560.49   .2457>
2400                 172.28    .3505    22467.71    .1013     1110.78    .2428     0
2410       72;   9.   2.   1.00    789801.11         0   718000.99         0>
2420                       0       0   129299.91         0  139300.00          0   .81
2430       73;   9.   2.   1.00      8657.91     .4395      6643.13   .4464>
2440                    .07   .9849     6520.05    .2478      472.56    .3857     0
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(continued)

Exhibit A-8 (continued)

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2450       74;   9.   2.  1.00     8657.91   .4395     6643.13  .4464>
2460                       .07   .9849    6520.05   .2478    472.56   .3857   .19
2470       75;   9.   2.  1.00    24999.99       0    24999.99      0>
2480                         0       0    4799.99       0   5200.00       0  1.00
2490       76;   9.   2.  1.00  1142940.53   .0318  1116263.95  .0258>
2500                  80163.02   .0015  129100.05       0  43880.94   .0180     0
2510       77;   9.   2.  1.00  1142940.53   .0318  1116263.95  .0258>
2520                  80163.02   .0015  129100.05       0  43880.94   .0180     0
2530       78;   9.   2.  1.00    24999.99       0    24999.99      0>
2540                         0       0    4799.99       0   5200.00       0   .17
2550       79;   9.   2.  1.00     2040.13   .3334     2213.39  .3215>
2560                     13.52   .3804   13153.78   .0727   2678.28   .1368   .35
2570       80;   9.   2.  1.00     2040.13   .3334     2213.39  .3215>
2580                     13.52   .3804   13153.78   .0727   2678.28   .1368     0
2590       81;  10.   2.  1.00    24999.99       0    24999.99      0>
2600                         0       0    4799.99       0   5200.00       0  1.00
2610       82;  10.   2.  1.00     1554.85   .5061     1340.06  .5089>
2620                     25.81   .5571     137.62   .4968    206.61   .4000     0
2630       83;  10.   2.  1.00     1554.85   .5061     1340.06  .5089>
2640                     25.81   .5571     137.62   .4968    206.61   .4000     0
2650       84;  10.   2.  1.00    24999.99       0    24999.99      0>
2660                         0       0    4799.99       0   5200.00       0   .35
2670       85;  10.   2.  1.00    90091.14   .0797    83534.08  .0792>
2680                    751.78   .1139   27019.25   .0257  11806.86   .0335   .38
2690       86;  10.   2.  1.00   111976.45   .0627   103788.07  .0623>
2700                   1152.63   .0806   30383.51   .0166  13048.24   .0257     0
2710       87;  12.   2.  1.00           0       0           0      0>
2720                         0       0          0       0         0       0     0
2730       88;  12.   2.  1.00  1359554.55   .0256  1178326.52  .0244>
2740                  81231.91   .0012  103269.41   .0176  40781.77   .0233   .40
2750       89;  12.   2.  1.00  1359554.55   .0256  1178326.52  .0244>
2760                  81231.91   .0012  103269.41   .0176  40781.77   .0233     0
2770       90;  13.   2.  1.00           0       0           0      0>
2780                         0       0          0       0         0       0     0
2790       91;  13.   2.  1.00  1359554.55   .0256  1178326.52  .0244>
2800                  81231.91   .0012  103269.41   .0176  40781.77   .0233   .40
2810       92;  13.   2.  1.00  1359554.55   .0256  1178326.52  .0244>
2820                  81231.91   .0012  103269.41   .0176  40781.77   .0233     0
2830       93;  14.   2.  1.00   217713.03   .1522   203535.93  .1499>
2840                    966.42   .2402    4227.97   .1984   3150.70   .2033   .75
2850       94;  14.   2.  1.00   217713.03   .1522   203535.93  .1499>
2860                    966.42   .2402    4227.97   .1984   3150.70   .2033     0
2870       95;  14.   2.  1.00   217713.03   .1522   203535.93  .1499>
2880                    966.42   .2402    4227.97   .1984   3150.70   .2033     0
2890       96;  15.   2.  1.00   217713.03   .1522   203535.93  .1499>
2900                    966.42   .2402    4227.97   .1984   3150.70   .2033   .32
2910       97;  15.   2.  1.00   217713.03   .1522   203535.93  .1499>
2920                    966.42   .2402    4227.97   .1984   3150.70   .2033     0
2930       98;  15.   2.  1.00   217713.03   .1522   203535.93  .1499>
2940                    966.42   .2402    4227.97   .1984   3150.70   .2033     0
2950       99;  16.   2.  1.00   217713.03   .1522   203534.93  .1499>
2960                    966.42   .2402    4227.97   .1984   3150.70   .2033   .75
2970      100;  16.   2.  1.00   217713.03   .1522   203535.93  .1499>
2980                    966.42   .2402    4227.97   .1984   3150.70   .2033     0
2990      101;  16.   2.  1.00   217713.03   .1522   203535.93  .1499>
3000                    966.42   .2402    4227.97   .1984   3150.70   .2033     0
3010      102;   4.   4.  1.00     2215.35   .5554     2117.36  .5510>
3020                      1.21   .8495    2550.05   .3479     84.82   .6083  1.00
3030      103;   5.   4.  1.00     8478.82   .3986     7707.92  .3986>
3040                         0       0  100199.96       0    671.18   .3874  1.00
3050      104;   5.   4.  1.00   385341.17   .1938   350319.68  .1938>
```

(continued)

Exhibit A-8 (continued)

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3060                    0         0  129299.91         0      337.92   .5244 1.00
3070    105;   5.   4.   3.90     265.14   .7587     235.84   .7590>
3080                     .04   .9999     109.93   .6058         3.36   .9712 1.00
3090    106;   5.   4.   1.00    3605.98   .4818    3219.14   .4760>
3100                     .09   .9567        .01  1.2364       587.75   .3432 1.00
3110    107;   5.   4.   3.90   11678.23   .4808    9009.89   .4806>
3120                     .02   .9967  304999.99         0       13.36   .7903 1.00
3130    108;   7.   4.   1.00    3023.94   .5409    2774.12   .5311>
3140                   16.90   .6868     739.59   .4223        54.92   .5705 1.00
3150    109;   8.   4.   1.00    7057.85   .5086    5537.89   .5096>
3160                     .99   .8815   34562.76   .1872       308.18   .4932 1.00
3170    110;   9.   4.   1.00    2747.91   .5562     378.13   .6502>
3180                     .13   .9963    3389.02   .3092      1056.11   .3862 1.00
3190    111;  10.   4.   1.00   12019.03   .5064   10684.84   .5071>
3200                   68.33   .7324   31793.78   .1762       144.07   .6258 1.00
3210    112;   1.   4.   1.00      32.13   .7674      25.54   .7749>
3220                       0  1.0000       1.65   .8467          .49   .9864 1.00
3230    113;   2.   4.   1.00      48.62   .7638      38.30   .7731>
3240                       0  1.0222       2.66   .8447          .43   .9689 1.00
3250    114;   4.   4.   1.00   12309.22   .3579   11553.25   .3549>
3260                  126.89   .4500    8669.38   .1911        30.51   .5676 1.00
3270    115;   4.   4.   1.00   16258.40   .2079   16647.22   .1998>
3280                  144.62   .2723   11428.83   .0909      1195.60   .2103 1.00
3290    116;   5.   4.   1.00  419999.79        0  349999.83        0>
3300                       0         0  436899.81         0    79299.93       0 1.00
3310    117;   5.   4.   1.00          0        0          0        0>
3320                       0         0  141600.03         0    54100.03       0 1.00
3330    118;   5.   4.   3.90    1003.39   .4578     934.58   .4556>
3340                   81.00   .3998      32.47   .5358       173.27   .3580 1.00
3350    119;   7.   4.   1.00     670.25   .5903     626.85   .5877>
3360                     .20  1.0053      27.63   .5980         5.68   .7120 1.00
3370    120;   7.   4.   3.49   10281.86   .2272    9680.21   .2244>
3380                   12.15   .3894   22016.49   .0386      3711.06   .1184 1.00
3390    121;   8.   4.   1.00   38176.56   .2449   34441.13   .2415>
3400                  220.14   .3370   22105.23   .1039      1793.59   .2108 1.00
3410    122;   8.   4.   1.00     261.24   .7606     239.50   .7581>
3420                     .64  1.0330   41078.75   .1499      1085.66   .3762 1.00
3430    123;   8.   4.   1.00   24999.99        0   24999.99        0>
3440                       0         0    4799.99         0     5200.00       0 1.00
3450    124;   9.   4.   1.00   33749.15   .2474   31560.49   .2457>
3460                  172.28   .3505   22467.71   .1013      1110.78   .2428 1.00
3470    125;   9.   4.   1.00    8657.91   .4395    6643.13   .4464>
3480                     .07   .9849    6520.05   .2478       472.56   .3857 1.00
3490    126;   9.   4.   1.00 1142940.53   .0318 1116263.95   .0258>
3500                80163.02   .0015  129100.05         0    43880.94   .0180 1.00
3510    127;   9.   4.   1.00    2040.13   .3334    2213.39   .3215>
3520                   13.52   .3804   13153.78   .0727      2678.28   .1368 1.00
3530    128;  10.   4.   1.00    1554.85   .5061    1340.06   .5089>
3540                   25.81   .5571     137.62   .4968       206.61   .4000 1.00
3550    129;  10.   4.   1.00 .111976.45   .0627  103788.04   .0623>
3560                 1152.63   .0806   30383.51   .0166     13048.24   .0257 1.00
3570    130;  12.   4.   1.00 1359554.55   .0256 1178326.52   .0244>
3580                81231.91   .0012  103269.41   .0176     40781.77   .0233 1.00
3590    131;  13.   4.   1.00 1359554.55   .0256 1178326.52   .0244>
3600                81231.91   .0012  103269.41   .0176     40781.77   .0233 1.00
3610    132;  14.   4.   1.00  217713.03   .1522  203535.93   .1499>
3620                  966.42   .2402    4227.97   .1984      3150.70   .2033   .75
3630    133;  15.   4.   1.00  217713.03   .1522  203535.93   .1499>
3640                  966.42   .2402    4227.97   .1984      3150.70   .2033   .32
3650    134;  16.   4.   1.00  217713.03   .1522  203535.93   .1499>
3660                  966.42   .2402    4227.97   .1984      3150.70   .2033   .75
```

Exhibit A-9

COST AND COVERAGE DATA FOR MISCELLANEOUS AIR POLLUTION CONTROLS

	Cost per Plant[1] (millions of 1976 dollars)	
	Capital	O&M
Existing Facilities	6.13	1.40
New Facilities	5.57	1.40

Coverage Data				
1976	1977	1978	1979	1980-1990
0.40	0.50	0.65	0.90	1.00

[1] Plant size is 204.7 million Btu per hour.

Exhibit A-10

MODEL PLANT COST DATA FOR WATER POLLUTION CONTROLS

(See Development Document, May 1982)

A-22

Exhibit A-11

COVERAGE DATA FOR WATER POLLUTION CONTROLS[1]

Page 1 of 3

BPT	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9
P1	0.507	0.587	0.620	0.643	0.667	0.690	0.831	0.973	1.114
P2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P3	0.583	0.675	0.728	0.792	0.857	0.921	0.947	0.974	1.000
P4	0.613	0.709	0.772	0.831	0.890	0.949	0.981	1.012	1.044
P5	0.598	0.598	0.598	0.598	0.598	0.598	0.732	0.866	1.000
P6	0.708	0.819	0.849	0.899	0.950	1.000	1.000	1.000	1.000
P7	0.708	0.819	0.849	0.891	0.934	0.977	0.985	0.992	1.000
P8	0.726	0.840	0.840	0.893	0.947	1.000	1.000	1.000	1.000
P9	0.732	0.758	0.764	0.770	0.776	0.782	0.855	0.927	1.000
P10	0.732	0.871	0.892	0.928	0.964	1.000	1.000	1.000	1.000
P11	0.283	0.327	0.429	0.527	0.626	0.724	0.816	0.908	1.000
P12	0.423	0.489	0.575	0.692	0.809	0.926	0.951	0.975	1.000
P13	0.765	0.765	0.765	0.765	0.765	0.765	0.843	0.922	1.000
P14	0.786	0.786	0.786	0.786	0.786	0.786	0.857	0.929	1.000
P15	0.691	0.800	0.818	0.851	0.884	0.917	0.945	0.972	1.000
P16	0.691	0.800	0.818	0.878	0.939	1.000	1.000	1.000	1.000
P17	0.691	0.800	0.818	0.822	0.827	0.832	0.888	0.944	1.000
P18	0.764	0.764	0.764	0.764	0.764	0.764	0.843	0.921	1.000
P19	0.814	0.814	0.814	0.814	0.814	0.814	0.876	0.938	1.000
P20	0.691	0.800	0.818	0.870	0.922	0.974	0.983	0.991	1.000
P21	0.678	0.678	0.678	0.678	0.678	0.678	0.785	0.893	1.000
P22	0.691	0.705	0.720	0.795	0.870	0.945	0.963	0.982	1.000
P23	0.593	0.593	0.593	0.593	0.593	0.593	0.729	0.864	1.000
P24	0.691	0.800	0.818	0.878	0.939	1.000	1.000	1.000	1.000
P25	0.416	0.481	0.481	0.586	0.690	0.795	0.863	0.932	1.000
P26	0.416	0.481	0.481	0.644	0.807	0.970	0.980	0.990	1.000
P27	0.416	0.481	0.481	0.654	0.827	1.000	1.000	1.000	1.000
P28	0.416	0.481	0.481	0.625	0.769	0.913	0.942	0.971	1.000
P29	0.631	0.730	0.730	0.775	0.819	0.864	0.909	0.955	1.000
P30	0.631	0.730	0.730	0.820	0.910	1.000	1.000	1.000	1.000
P31	0.405	0.469	0.558	0.639	0.721	0.803	0.869	0.934	1.000
P32	0.405	0.469	0.558	0.685	0.813	0.940	0.960	0.980	1.000
P33	0.364	0.421	0.517	0.533	0.549	0.565	0.710	0.855	1.000
P34	0.364	0.421	0.517	0.586	0.655	0.724	0.816	0.908	1.000
P35	0.364	0.421	0.517	0.678	0.839	1.000	1.000	1.000	1.000
P36	0.364	0.421	0.517	0.651	0.784	0.918	0.945	0.973	1.000
P37	0.364	0.421	0.517	0.584	0.650	0.716	0.811	0.905	1.000
P38	0.503	0.582	0.652	0.705	0.759	0.813	0.875	0.938	1.000
P39	0.503	0.582	0.652	0.765	0.879	0.993	0.995	0.998	1.000
P40	0.336	0.389	0.439	0.594	0.748	0.902	0.935	0.967	1.000
P41	0.336	0.389	0.439	0.615	0.790	0.965	0.977	0.988	1.000
P42	0.336	0.389	0.439	0.626	0.813	1.000	1.000	1.000	1.000
P43	0.336	0.389	0.439	0.597	0.755	0.913	0.942	0.971	1.000
P44	0.336	0.389	0.439	0.626	0.813	1.000	1.000	1.000	1.000
P45	0.336	0.389	0.439	0.626	0.813	1.000	1.000	1.000	1.000
P46	0.336	0.389	0.439	0.626	0.813	1.000	1.000	1.000	1.000
P47	0.336	0.389	0.439	0.626	0.813	1.000	1.000	1.000	1.000
P48	0.515	0.596	0.630	0.739	0.847	0.956	0.971	0.985	1.000
P49	0.515	0.596	0.630	0.740	0.851	0.961	0.974	0.987	1.000
P50	0.515	0.596	0.630	0.730	0.829	0.929	0.953	0.976	1.000
P51	0.515	0.596	0.630	0.753	0.877	1.000	1.000	1.000	1.000
P52	0.498	0.576	0.611	0.738	0.865	0.992	0.995	0.997	1.000
P53	0.498	0.576	0.611	0.739	0.867	0.995	0.997	0.998	1.000
P54	0.498	0.576	0.611	0.733	0.854	0.976	0.984	0.992	1.000
P55	0.498	0.576	0.611	0.741	0.870	1.000	1.000	1.000	1.000
P56	0.498	0.576	0.611	0.702	0.792	0.882	0.921	0.961	1.000
P57	0.372	0.431	0.526	0.641	0.757	0.872	0.915	0.957	1.000
P58	0.372	0.431	0.526	0.669	0.813	0.956	0.971	0.985	1.000
P59	0.372	0.431	0.526	0.650	0.775	0.899	0.933	0.966	1.000
P60	0.372	0.431	0.526	0.602	0.679	0.756	0.837	0.919	1.000
P61	0.215	0.249	0.374	0.554	0.733	0.912	0.941	0.971	1.000
P62	0.215	0.249	0.374	0.518	0.661	0.805	0.870	0.935	1.000
P63	0.419	0.419	0.419	0.419	0.419	0.419	0.613	0.806	1.000
P64	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P65	0.561	0.649	0.707	0.805	0.902	1.000	1.000	1.000	1.000
P66	0.561	0.649	0.707	0.805	0.902	1.000	1.000	1.000	1.000

(continued)

Exhibit A-11 (continued)

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BAT	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9
P1	0.180	0.208	0.208	0.218	0.229	0.239	0.493	0.746	1.000
P2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P3	0.059	0.059	0.059	0.067	0.076	0.085	0.390	0.695	1.000
P4	0.126	0.126	0.126	0.165	0.204	0.243	0.495	0.748	1.000
P5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P6	0.000	0.000	0.000	0.260	0.519	0.779	0.853	0.926	1.000
P7	0.000	0.000	0.000	0.041	0.083	0.124	0.416	0.708	1.000
P8	0.000	0.000	0.000	0.062	0.124	0.186	0.458	0.729	1.000
P9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P10	0.000	0.000	0.000	0.099	0.198	0.297	0.531	0.766	1.000
P11	0.031	0.031	0.031	0.021	0.010	0.000	0.333	0.667	1.000
P12	0.000	0.000	0.000	0.121	0.242	0.363	0.575	0.788	1.000
P13	0.136	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
P14	0.136	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
P15	0.162	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
P16	0.162	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
P17	0.157	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
P18	0.157	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
P19	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136
P20	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136
P21	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027
P22	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027
P23	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130
P24	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130
P25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P26	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P27	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P28	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P31	0.000	0.000	0.000	0.009	0.017	0.026	0.026	0.026	0.026
P32	0.000	0.000	0.000	0.009	0.017	0.026	0.026	0.026	0.026
P33	0.000	0.000	0.000	0.041	0.082	0.123	0.123	0.123	0.123
P34	0.000	0.000	0.000	0.041	0.082	0.123	0.123	0.123	0.123
P35	0.000	0.000	0.000	0.041	0.082	0.123	0.123	0.123	0.123
P36	0.000	0.000	0.000	0.041	0.082	0.123	0.123	0.123	0.123
P37	0.000	0.000	0.000	0.041	0.082	0.123	0.123	0.123	0.123
P38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P39	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P40	0.201	0.232	0.233	0.250	0.266	0.283	0.283	0.283	0.283
P41	0.201	0.232	0.233	0.250	0.266	0.283	0.283	0.283	0.283
P42	0.201	0.232	0.233	0.250	0.266	0.283	0.283	0.283	0.283
P43	0.201	0.232	0.233	0.250	0.266	0.283	0.283	0.283	0.283
P44	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P45	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P46	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P47	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P48	0.080	0.092	0.092	0.255	0.418	0.581	0.581	0.581	0.581
P49	0.080	0.092	0.092	0.255	0.418	0.581	0.581	0.581	0.581
P50	0.080	0.092	0.092	0.255	0.418	0.581	0.581	0.581	0.581
P51	0.080	0.092	0.092	0.255	0.418	0.581	0.581	0.581	0.581
P52	0.000	0.000	0.000	0.007	0.015	0.022	0.022	0.022	0.022
P53	0.000	0.000	0.000	0.007	0.015	0.022	0.022	0.022	0.022
P54	0.000	0.000	0.000	0.007	0.015	0.022	0.022	0.022	0.022
P55	0.000	0.000	0.000	0.007	0.015	0.022	0.022	0.022	0.022
P56	0.000	0.000	0.000	0.007	0.015	0.022	0.022	0.022	0.022
P57	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120
P58	0.338	0.391	0.391	0.425	0.458	0.492	0.661	0.831	1.000
P59	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120
P60	0.338	0.391	0.391	0.538	0.686	0.833	0.889	0.944	1.000
P61	0.112	0.112	0.112	0.114	0.117	0.120	0.120	0.120	0.120
P62	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.667	1.000
P63	0.112	0.112	0.112	0.114	0.117	0.120	0.120	0.120	0.120
P64	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P65	0.000	0.000	0.000	0.040	0.080	0.120	0.120	0.120	0.120
P66	0.000	0.000	0.000	0.333	0.667	1.000	1.000	1.000	1.000

(continued)

Exhibit A-11 (continued)

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PSES	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9
P1	0.180	0.208	0.208	0.402	0.596	0.790	0.860	0.930	1.000
P2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P3	0.138	0.160	0.160	0.407	0.653	0.900	0.933	0.967	1.000
P4	0.150	0.174	0.178	0.436	0.695	0.953	0.969	0.984	1.000
P5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P6	0.000	0.000	0.000	0.333	0.667	1.000	1.000	1.000	1.000
P7	0.000	0.000	0.000	0.333	0.667	1.000	1.000	1.000	1.000
P8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P10	0.000	0.000	0.000	0.333	0.667	1.000	1.000	1.000	1.000
P11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P12	0.000	0.000	0.000	0.329	0.658	0.987	0.991	0.996	1.000
P13	0.162	0.188	0.206	0.471	0.735	1.000	1.000	1.000	1.000
P14	0.162	0.188	0.206	0.438	0.669	0.901	0.934	0.967	1.000
P15	0.162	0.188	0.206	0.368	0.529	0.691	0.794	0.897	1.000
P16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P17	0.162	0.188	0.206	0.406	0.606	0.806	0.871	0.935	1.000
P18	0.162	0.188	0.206	0.471	0.735	1.000	1.000	1.000	1.000
P19	0.162	0.188	0.206	0.471	0.735	1.000	1.000	1.000	1.000
P20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P21	0.162	0.188	0.206	0.471	0.735	1.000	1.000	1.000	1.000
P22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P23	0.162	0.188	0.206	0.471	0.735	1.000	1.000	1.000	1.000
P24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P26	0.046	0.053	0.053	0.115	0.176	0.238	0.492	0.746	1.000
P27	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P28	0.046	0.053	0.053	0.070	0.088	0.105	0.403	0.702	1.000
P29	0.000	0.000	0.000	0.106	0.212	0.318	0.545	0.773	1.000
P30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P31	0.000	0.000	0.000	0.333	0.667	1.000	1.000	1.000	1.000
P32	0.000	0.000	0.000	0.333	0.667	1.000	1.000	1.000	1.000
P33	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.667	1.000
P34	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.667	1.000
P35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P38	0.000	0.000	0.000	0.333	0.667	1.000	1.000	1.000	1.000
P39	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P40	0.215	0.249	0.250	0.312	0.373	0.435	0.623	0.812	1.000
P41	0.215	0.249	0.250	0.337	0.425	0.512	0.675	0.837	1.000
P42	0.215	0.249	0.250	0.270	0.290	0.310	0.540	0.770	1.000
P43	0.215	0.249	0.250	0.359	0.469	0.578	0.719	0.859	1.000
P44	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P45	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P46	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P47	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P48	0.085	0.098	0.098	0.395	0.692	0.989	0.993	0.996	1.000
P49	0.085	0.098	0.098	0.149	0.200	0.251	0.501	0.750	1.000
P50	0.085	0.098	0.098	0.176	0.255	0.333	0.555	0.778	1.000
P51	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P52	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P53	0.000	0.000	0.000	0.019	0.038	0.057	0.371	0.686	1.000
P54	0.000	0.000	0.000	0.133	0.266	0.399	0.599	0.800	1.000
P55	0.000	0.000	0.000	0.267	0.533	0.800	0.867	0.933	1.000
P56	0.000	0.000	0.000	0.082	0.165	0.247	0.498	0.749	1.000
P57	0.265	0.265	0.265	0.265	0.265	0.265	0.510	0.755	1.000
P58	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P59	0.338	0.391	0.391	0.498	0.606	0.713	0.809	0.904	1.000
P60	0.338	0.391	0.391	0.468	0.546	0.623	0.749	0.874	1.000
P61	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P62	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P63	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P64	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P65	0.000	0.000	0.000	0.047	0.093	0.140	0.427	0.713	1.000
P66	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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[1] Processes P1-P66 indicated on Exhibit 19; years Y1-Y9 correspond to 1976-1984.

Exhibit A-12

SUBCATEGORY/PRODUCTION PROCESS CONVERSION DATA

Page 1 of 3

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 100   C ::::::::::::::WATER DATA  -  1981 VERSION:::::::::::::::::::::::
 300   C       FRACTIONS OF CAPACITY DISCHARGING DIRECTLY AND INDIRECTLY
 400   C       CAPACITY BREAKDOWN FIRST BY ADL CATAGORY AND THEN BY
 500   C          RICE CATAGORY
 600   C            INPUT 8/14/81   DWS
 650   C       CORRECTIONS MADE FOR REVISED ADL CAPACITIES 8/31/81  DWS
 675   C       ADJUSTMENTS MADE FOR EXPECTED NEW ADDITIONS 9/1/81   RPM
 676   C       CORRECTIONS 9/21/81  RPM
 688   C       CORRECTIONS 9/22/81 DWS
 694   C       MAJOR UPDATE 12/1/81 JPF
 700   C :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 800   C           ADL#     RICE#   DIRECT   INDIRECT   NEW
 900    1;         4      3      .5050      .0236      .5286
1000    2;         5      1      .7361      .1653     1.0000
1100    3;         5      2       0         0          0
1200    4;         7 .    4      .9780      .0216     1.0000
1300    5;         8      8      .4891      0         .4891
1400    6;         9      5      .2169      0        .2169
1500    7;         9      6      .1628      .0314      .1942
1600    8;         9      7      .5397      .0491      .5888
1700    9;         10      9     .0661      0        .0661
1800    10;          10      10     .1069     .0200      .1269
1900    11;          12      12     .8604      .1396      1
2000    12;          13      12     .9562      .0438      1
2100    13;           14      13      .4964     0        .4964
2200    14;          14      14     .3713    .0290      .4003
2300    15;          14      15     .0292 .    .0042      .0334
2400    16;          14      16     .0738      0      .0738
2500    17;          14      17     .0313      0      .0313
2600    18;          14      18     .0072      0      .0072
2700    19;          14      42     .0111      0     .0111
2800    20;          15      13      .0043      0      .0043
2900    21;          15      14     .0106      0     .0106
3000    22;          15      17     .8645     .0994       .9639
3100    23;          15      18     .1216      .0002     .1218
3200    24;            15      29      .0001     0      .0001
3300    25;          15      42     .0124             0       .0124
3400    26;          16      13     .2858     .0073      .2931
3500    27;          16      14     .6234     .0397      .6631
3600    28;          16      15     .0376     .0005     .0381
3700    29;          16      16     .0077      0      .0077 .
3800    30;          16      20     .0025      0      .0025
3900    31;          17      13     .0043          0       .0043
4000    32;          17      17      .6058     .0763      .6821
4100    33;          17      18     .0272    .0002      .0274
4200    34;          17      31      .0027     0      .0027
4300    35;          18      13    0        0      0
4400    36;          18      17      .3223      .0450       .3673
4500    37;          18      18     .0328      .0002      .0330
4600    38;          18      19     .0009     0      .0009
4700    39;          18      26      .0022      .0006      .0028
4800    40;          18      29      .0037     0      .0037
4900    41;          18      31      .0001  -   .0001      .0002
5000    42;          18      40      0      .00031     0
5100    43;          18      41     .0589      .0276  .   0
5200    44;          18      42      .0699      .0029     0
5300    45;          18      43      0      .0009     0
5400    46;          18      45      0      0      .1605
5500    47;          18      49      0      0      0
5600    48;          18      54      .0278      .0021      .0299
5700    49;          18      55     .0018      .0015      .0033
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(continued)

Exhibit A-12 (continued)

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 5800     50;     18     57     0       0       0
 5900     51;     19     17     .2587       0      .2587
 6000     52;     19     18    .0111      0      .0111
 6100     53;     19     26    .0109    0     .0109
 6200     54;     19     29     .0046      .0109     .0155
 6300     55;     19     31     .0175      .0028      .0203
 6400     56;     19     32     .0397      .0066      .0463
 6500     57;     19     41     .0316      .0144      0
 6600     58;     19     42     .0066      0         0
 6700     59;     19     43     0      .0167       0
 6800     60;     19     45     .0397      0       .2186
 6900     61;     19     49     .0301      .0304      0
 7000     62;     19     54     .0466      .0025      0
 7100     63;     19     59     .0967      .0033      1.000
 7200     64;     19     60     .0306      .0096      .0402
 7300     65;     19     63     .0020      .0013      .0033
 7400     66;     20     36     .0068      0       .0068
 7500     67;     21     23     .6077      .0271      .6348
 7600     68;     21     24     .1451      0       .1451
 7700     69;     21     27     .0021      0      .0021
 7800     70;     21     31    .0233     .0001      .0234
 7900     71;     21     32    .0019     0      .0019
 8000     72;     21     38    .0170       0      .0170
 8100     73;     21     39     .0052      0       .0052
 8200     74;     21     40     .0085      0       0
 8300     75;     21     42     .0037      0       0
 8400     76;     21     43     .1017      .0054      0
 8500     77;     21     47    0       0      .1423
 8600     78;     21     50     .0058      0  0
 8700     79;     21     56     .0162      .0010      0
 8800     80;     21     57     .0259      0      .0259
 8900     81;     21     58     .0224      0       .0224
 9000     82;     22     13     .0052      0       .0052
 9100     83;     22     17     .0414      .0009      .0423
 9200     84;     22     19     .7312      .0242      .7754
 9300     85;     22     20     .0212      0       .0212
 9400     86;     22     25    .0008     0      .0008
 9500     87;     22     28    .0027      .0009      .0046
 9600     88;     22     30    .0001     0      .0001
 9700     89;     22     31     .0033      .0001      .0034
 9800     90;     22     32     .1343      .0095      .1438
 9900     91;     22     40    .2343     .0022      0
10000     92;     22     41     .0004       0       0
10100     93;     22     44     0       0      .7993
10200     94;     22     48     .4280      .0179      0
10300     95;     22     51     .0722       0       0
10400     96;     22     52     .0010      0      0
10500     97;     22     53     .0431      .0002       0
10600     98;     22     57     .0531      .0029      .0560
10700     99;     22     58     .0330      0      .0330
10800     100;      22     61     .0002      0      .0002
10900     101;      22     62     .0039      0      .0039
11000     102;      22     63     .0056      0      .0056
11100     103;      24     23     .4394     0      .4394
11200     104;      24     24     .0456      0      .0456
11300     105;      24     27     .0027      0      .0027
11400     106;      24     31     .0259      .0001      .0260
11500     107;      24     38     .3199      .0010      .3209
11600     108;      24     39     .1375      0      .1375
11700     109;      24     40     .0101      0      0
11800     110;      24     42     .0044      0      0
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(continued)

Exhibit A-12 (continued)

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11900	111[1]	24	43	.1241	.0143	0
12000	112[1]	24	47	0	0	.1867
12100	113[1]	24	50	.0089	0	0
12200	114[1]	24	56	.0229	.0020	0
12300	115[1]	24	57	.0311	0	.0311
12400	116[1]	24	58	.0271	0	.0271
12500	117[1]	25	33	.0445	.0128	.0573
12600	118[1]	25	34	.4187	.0175	.4362
12700	119[1]	25	35	.3876	0	.3876
12800	120[1]	25	36	.1460	0	.1460
12900	121[1]	25	37	.2097	0	.2097
13000	122[1]	27	32	.0301	0	.0301
13100	123[1]	28	15	0	0	0
13200	124[1]	28	17	.0051	0	.0051
13300	125[1]	28	18	0	0	0
13400	126[1]	28	19	.2803	.0163	.2966
13500	127[1]	28	20	.0100	0	.0100
13600	128[1]	28	21	.6835	.0698	.7533
13700	129[1]	28	22	.0967	0	.0967
13800	130[1]	28	25	.0003	0	.0003
13900	131[1]	28	40	.0363	0	0
14000	132[1]	28	42	.0017	0	0
14100	133[1]	28	43	0	.0009	0
14200	134[1]	28	48	.0299	0	0
14300	135[1]	28	52	.0165	0	0
14400	136[1]	28	57	0	.0005	.0005
14450	137[1]	28	44	0	0	.0783
14500	138[1]	30	11	.089	0	.089
14600	139[1]	30	11	.089	0	.089
14700	140[1]	30	11	.089	0	.089

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[1] Numbered in Exhibits 10 and 19.

Exhibit A-13

MAJOR FINANCIAL ASSUMPTIONS

HISTORICAL DATA					
	Real Return on Equity (percent)	Dividend Payout Ratio[1] (percent)	Additions to Common Stock (millions of dollars)	Debt Refunding Rate (percent of 1976 debt)	Interest Rate on Debt[2] (percent)
1976	0.44%	47.6%	$1,171.6	3.3%	6.8%
1977	0.88	373.0	1,003.6	3.7	9.7
1978	4.70	41.3	443.0	4.1	8.9
1979	9.15	51.4	765.4	4.1	9.3
1980	5.91	36.9	0.0	4.1[a]	2.7[a]

TAX RATES (percent)	
Federal	46.00%
State	7.55
Property	2.38
Sales	3.99
Investment Tax Credit	10.00

BALANCE SHEET--1976 ($ millions)	
Long-Term Debt	$ 4,934.2
Working Capital	4,089.8
Capital Equipment	17,084.9
Equity	12,130.7
Deferred Taxes	2,557.0

FACTORS USED TO CONVERT CAPITAL EXPENDITURES TO CASH FLOWS						
	Capital Expenditures	Cash Flow				
	Year 0	Year 0	Year 1	Year 2	Year 3	Year 4
Production Equipment						
1976-1982	1.00	0.15	0.35	0.35	0.15	0.00
1983-1984	1.00	0.10	0.30	0.30	0.20	0.10
Pollution Control Equipment	1.00	0.20	0.40	0.40	0.00	0.00

[1] 45 percent for 1980-1990.
[2] 1976-1979 are nominal rates; 1980-1990 are real rates.
[a] Repeated to 1990.

Exhibit A-14

INTEREST RATES AND COST ESCALATION FACTORS FOR 1976 PRICES

	GNP	Capital Expenditures	Labor and Overhead	Other Raw Materials	Power	Fuel	Iron Ore	Coal	Scrap	Interest Rates
1976	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	6.8%
1977	1.060	1.052	1.111	1.060	1.126	1.228	1.053	1.118	0.812	9.7
1978	1.137	1.121	1.218	1.137	1.251	1.322	1.154	1.234	0.980	8.9
1979	1.239	1.194	1.356	1.239	1.377	1.792	1.257	1.293	1.258	9.3
1980	1.350	1.272	1.572	1.350	1.638	2.443	1.297	1.341	1.319	11.7
1981	1.477	1.352	1.685	1.504	1.874	2.912	1.380	1.434	1.443	9.9
1982	1.594	1.425	1.892	1.659	2.099	3.299	1.486	1.551	1.557	10.6
1983	1.707	1.499	2.110	1.795	2.307	3.897	1.633	1.712	1.668	9.8
1984	1.806	1.567	2.327	1.942	2.505	4.559	1.798	1.894	1.764	8.5
1985	1.901	1.631	2.546	2.086	2.678	5.220	1.975	2.089	1.858	8.0
1986	1.985	1.686	2.745	2.230	2.908	5.961	2.168	2.304	1.939	7.1
1987	2.062	1.735	2.931	2.372	3.129	6.772	2.355	2.514	2.015	6.6
1988	2.157	1.806	3.125	2.529	3.348	7.666	2.543	2.727	2.108	7.3
1989	2.250	1.877	3.325	2.688	3.556	8.616	2.729	2.940	2.198	7.0
1990	2.347	1.944	3.531	2.847	3.751	9.366	2.917	3.134	2.293	7.0

Source: Data Resources, Inc. OPTIMLONG0681; AISI Annual Statistical Reports; TBS analysis.

Exhibit A-15

SENSITIVITY ANALYSIS--HIGHER INFLATION RATES

INTEREST RATES AND COST ESCALATION FACTORS FOR 1976 PRICES

	GNP	Capital Expenditures	Labor and Overhead	Other Raw Materials	Power	Fuel	Iron Ore	Coal	Scrap	Interest Rates
1976	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	6.8%
1977	1.060	1.052	1.111	1.060	1.126	1.228	1.053	1.118	0.812	9.7
1978	1.137	1.121	1.218	1.137	1.251	1.322	1.154	1.234	0.980	8.9
1979	1.239	1.194	1.356	1.239	1.377	1.792	1.257	1.293	1.258	9.3
1980	1.350	1.272	1.572	1.350	1.638	2.443	1.297	1.341	1.319	11.7
1981	1.479	1.353	1.680	1.479	1.875	2.919	1.383	1.436	1.444	12.3
1982	1.609	1.439	1.850	1.609	2.119	3.445	1.508	1.574	1.571	11.5
1983	1.744	1.531	2.070	1.744	2.365	4.068	1.676	1.757	1.703	11.1
1984	1.901	1.647	2.333	1.901	2.639	4.910	1.907	2.008	1.857	11.7
1985	2.076	1.790	2.589	2.076	2.972	5.907	2.188	2.313	2.028	11.9
1986	2.265	1.951	2.853	2.265	3.346	7.047	2.500	2.655	2.212	11.8
1987	2.446	2.110	3.110	2.446	3.731	8.245	2.803	2.990	2.389	10.7
1988	2.649	2.261	3.440	2.649	4.104	9.614	3.122	3.346	2.587	11.0
1989	2.880	2.433	3.828	2.880	4.555	11.268	3.525	3.794	2.812	11.4
1990	3.130	2.633	4.200	3.130	5.093	13.048	3.983	4.306	3.057	11.4

Source: Data Resources, Inc. CYCLELONG0681; AISI Annual Statistical Reports; TBS analysis.

Exhibit A-16

MAJOR ECONOMIC ASSUMPTIONS

1. Relationship of real return on equity (r) to capacity utilization (u).

   - For $u \leq 85\%$, $r = 0$
   - For $u > 85\%$, $r = \text{all-manufacturing return} \times (u - 85\%) + 15\%$

   Note: Relationship does not include return on equity added for the sensitivity analysis examining 100 percent pass-through of cost savings and profit.

   All-Manufacturing Real Return on Equity 1981-1990 (percent)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Return	1.9%	2.8%	3.6%	4.2%	4.6%	4.4%	4.7%	5.0%	8.2%	5.3%

2. Relationship of cost savings (s) to capacity declines (d).

   - For $d \leq 3$ million tons, $s = (\$80/\text{ton})d$
   - For $d > 3$ million tons, $s = \$240 \text{ million} + [(\$30/\text{ton})(d - 3.0)]$

3. Relationship of capacity decline to reduced expenditures for existing equipment (see p. II-10).

4. Relationship of production, market share, and employment to capacity constraints.

   Production, market share, and employment levels required to gain a full 84.5 percent domestic market share are reduced when the utilization rate of raw steel capacity exceeds 90 percent in the following equation.

   $x = x \text{ at } 84.5\% \text{ market share} \times (90\% + \text{utilization of raw steel production})$